

**M.Tech. Degree
PROGRAMME**

in

TRANSPORTATION ENGINEERING

CURRICULUM

(w. e. f. Session 2019-2020)



**DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
KURUKSHETRA - 136119**

VISION AND MISSION OF THE INSTITUTE

VISION OF THE INSTITUTE

To be a role-model in technical education and research, responsive to global challenges.

MISSION

To impart technical education that develops innovative professionals and entrepreneurs and to undertake research that generates cutting-edge technologies and futuristic knowledge, focusing on the socio-economic needs.

VISION AND MISSION OF THE DEPARTMENT

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To be a role-model in Civil Engineering Education and Research responsive to global challenges.

MISSION

1. To impart quality Civil Engineering Education that develops innovative professional & entrepreneurs.
2. To undertake research that generates cutting-edge technologies & futuristic knowledge, focusing on the socio-economic needs.
3. To prepare professionals with emphasis on leadership, team work and ethical conduct.

VISION AND MISSION OF THE PROGRAM

VISION OF THE PROGRAM

To be a role-model in Transportation Engineering Education and Research responsive to global challenges.

MISSION

1. To impart quality Transportation Engineering Education that develops innovative professionals to undertake research / investigations / developmental works independently.
2. To develop professionals with mastery in the transportation engineering field to generate cutting-edge technologies & futuristic knowledge, focusing on the socio-economic needs.
3. To prepare professionals with emphasis on leadership, team work, adaption to changing needs and ethical conduct.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Post Graduates of the Program will

- PEO-1 Contribute to the development of transportation infrastructure that is safe, efficient and sustainable.
- PEO-2 Demonstrate their expertise in the field of Transportation Engineering to address various societal problems.
- PEO-3 Continue to learn ever changing technologies and new developments.
- PEO-4 Lead and accomplish their assignments with spirit of team work and ethical conduct.

PROGRAMME OUTCOMES (POs)

Post-Graduates of the Program will be able to:

- PO-1 Carry out research /investigation and development work to solve practical problems in the field of transportation.
- PO-2 Write and present a substantial technical report / document on transportation issues.
- PO-3 Acquire a degree of mastery in the field of transportation engineering.
- PO-4 Recognize the need of adapting to the ever changing technologies and new developments in the field of Transportation Engineering.
- PO-5 Learn to accomplish their assignments with spirit of team work and ethical conduct.

Scheme of M.Tech Civil Engineering(Transportation Engineering)

S.No	Course No.	Subject	Teaching Schedule				Credits
			L	T	P	Total	
SEMESTER-I							
1	MCE4C01	Traffic Engineering	3			3	3
2	MCE4C03	Advanced Highway Design & Analysis	3			3	3
3	MCE4C05	Pavement Materials	3			3	3
4		Elective-I	3			3	3
5		Elective-II	3			3	3
6	MCE4S07	Seminar-I			2	2	1
7	MCE4L09	Advanced Transportation Lab			4	4	2
			15		6	21	18
SEMESTER-II							
1	MCE4C02	Pavement Analysis & Design	3			3	3
2	MCE4C04	Pavement Construction, Maintenance & Management	3			3	3
3		Elective-III	3			3	3
4		Elective-IV	3			3	3
5		Elective-V	3			3	3
6	MCE4S08	Seminar-II			2	2	1
7	MCE4L10	Computational Lab			4	4	2
			15		6	21	18
SUMMER ACADEMIC ACTIVITY							
		Preparatory Work for Dissertation	-	-	-	-	-
SEMESTER-III							
	MCE4-D/P/I-11	Dissertation/Project work/Internship-Part-I			28	28	14
SEMESTER-IV							
	MCE4-D/P/I-12	Dissertation/Project work/Internship-Part-II			28	28	14
Total						64	

- Electives can be opted from the list of electives / core subjects of various specialisations of Civil Engg Department.
- Elective-V can also be opted from the list of electives of other departments as well.
- List of Electives being offered by the Department with number of slots and pre-requisites, if any, will be floated by the concerned department well before the registration.

Electives for Odd Sem		Electives for Even Sem	
MCE4E31	Numerical Methods & Applied Statistics	MCE4E32	Transportation Planning
MCE4E33	Transportation Drainage Systems	MCE4E34	Public Transportation
MCE4E35	Transportation Systems Planning & Design	MCE4E36	Intelligent Transportation Systems
MCE4E37	Transportation Economics & Finance	MCE4E38	GIS in Transportation
MCE4E39	Financing Transportation Projects	MCE4E40	Project Management

Open Elective	
MCE4O71/72	Transportation Safety & Environment

MCE4C01 Traffic Engineering

L T P/D Total Credit
3- - 33

Theory: Max. Marks: 100
50 Marks
Sessional : 50 Marks
Duration: 3 Hours

Course Objectives:

1. To understand how to carry out various traffic studies
2. To learn the concept of traffic capacity of roads and its application
3. To learn the macroscopic and microscopic models of traffic flow and their application
4. To acquaint with road safety audit and its application
5. To understand the design of road intersections

Course Contents:

Traffic Studies: Traffic volume study, speed study and origin and destination study.

Capacity and Level of Service: Fundamental diagram of traffic flow. Design service volume. Capacity of non-urban roads. & urban roads. Discrete and continuous probability distributions. Merging manoeuvres - critical gaps and their distribution.

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 - Vehicle trajectories - Acceleration noise.

Traffic Accidents: Causes and preventive measures. Road Safety Audit – Countermeasures, evaluation of counter-measures – Road safety programmes. Traffic management.

Design of traffic signals. Design of a rotary. Types of grade separated intersections.

Recommended Books

- (i) Principles of Transportation Engineering by Chakraborty & Das, Prentice Hall, India.
- (ii) Highway Engg by S.K. Khanna & C.E.G. Justo, Nem Chand Bros., Roorkee.
- (iii) Traffic Engg and Transport Planning by L.R. Kadiyali, Khanna Publishers, Delhi.
- (iv) Principles of Transportation and Highway Engineering by G.V. Rao, Tata McGraw-Hill Publishing Co. Ltd. N. Delhi.
- (v) Traffic Engg. by Matson, T.M., Smith, W.S. and Hurd, F.W, McGraw- Hill Book Co., New York.
- (vi) Traffic Flow Theory by Drew, D.R., McGraw- Hill Book Co., New York.
- (vii) Traffic Flow Theory - A Monograph, TRB, SR165, 1975.
- (viii) Indo-HCM, 2018 and relevant IRC codes

Course Outcomes:

Upon completion of this course, the students will be able to:

1. Make investigations for collection of field traffic data
2. Prepare a report to judge adequacy of existing road network
3. Demonstrate expertise in the application of various models of traffic flow
4. Carry out road safety audit
5. Design rotary and signalised intersections of roads

MCE4C03 Advanced Highway Design and Analysis

L	T	P/D	Total	Credit
3	-	-	3	3

Max. Marks:	100
Theory:	50 Marks
Sessional :	50 Marks
Duration:	3 Hours

Course Objectives:

1. To learn about road geometric
2. To understand the factor affecting geometric design
3. To understand sight distance requirement for safe movement on highways
4. To understand the horizontal and vertical alignment requirement and design

Course Content:

Introduction to highway geometric design: Development IRC and AASHTO geometric design polices, Definition and scope of geometric design, Primary and dependent design controls.

Human and vehicle factors: Concepts and application of human factors in design and typical vehicle factors used in geometric design.

Sight distance: Overview of different type of sight distance, sight distance index, scaling and recording sight distance from plans, sight distance profile.

Longitudinal Features of Horizontal and Vertical Profile: Factors influencing profile selection, horizontal curve, vertical curve, curves for special situation, characteristics of highway alignment, general principles of horizontal and vertical profile coordination and technique, elements of highway cross sections, developing cross sections, methods of attaining super elevation and graphical development of super elevation.

Highway location and alignment design: Location study, developing trial alignment, evaluating impacts, single line sketching technique.

Principles of intersection and interchange design: Design objectives, driver expectancy, geometric design controls, alignment and profile, lane width, design for turning movements, treatments for right turns, unconventional intersection and interchange design, channelization
Introduction to highway design software

Recommended Books

1. A policy on geometric design of highways and streets, American Association of State Highway Officials, 2011.
2. Geometric design standards for urban roads in plains (IRC: 86- 1983), The Indian Roads Congress, 1983.
3. Geometric design standards for rural (non-urban) highways (IRC: 73-1980), The Indian Roads Congress, 1980.
4. Guidelines for expressways – Part I, Ministry of Road Transport & Highways, 2010.
5. Roadside design guide, American Association of State Highway Officials, 2002.
6. Various other relevant codes on geometric design such as IRC:SP:87-2010, IRC:SP:84-2009, IRC:SP:48-1998, IRC:92-1985
7. Pline, J.L., Traffic Engineering Handbook, Institute of Transportation Engineers, 2009.
8. Manual on Uniform Traffic Control Devices, Federal Highway Administration, 2009.
9. S.K. Khanna and C.E.G. Justo, Highway Engineering, Khanna Publishers, Roorkee, 2001

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

1. understand the concepts of cross-sectional elements of highway
2. workout sight distance requirements
3. Design horizontal and vertical alignment
4. Carryout intersection design

MCE4C05 Pavement Materials

L T P/D Total Credit
3- - 33.0

Max. Marks: 100
Theory: 50 Marks
Sessional : 50 Marks
Duration: 3 Hours

Course Objectives:

1. To understand the desirable properties of subgrade soil, aggregates, bituminous and other such materials
2. To learn the standard testing procedure for these materials
3. To know the standard specifications to judge suitability of the materials
4. To learn the granular, bituminous and concrete mix designs and their application

Course Contents:

Sub grade: Index Properties of Soil, Soil Classification based on Grain size, Soil Classification Systems, Evaluation of soil Strength.

Aggregates: Introduction, Desirable properties of Road Aggregates, Tests for Road Aggregates.

Bituminous Materials: Introduction, Types of Bituminous materials, Tests on Bituminous materials. Polymer and Rubber Modified binders. Visco elastic properties of bitumen and bituminous mixture.

Bituminous Mixes: Granular mix design, Design of Bituminous Mix, Mechanical properties - Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes. Marshall method of bituminous mix design. Performance based mix design Approaches. Superpave.

Cement concrete based materials: Concrete Mix Design. Special types of cement concrete: polymer concrete composites, fibre reinforced concrete, ferrocement, roller compacted concrete, high strength concrete, high performance, self compacting concrete.

Reclaimed / Recycled Waste Products and other materials: Reclaimed Materials, Waste Products, Self healing and smart materials – locally available materials. Composites, Plastics and Geosynthetics.

Recommended Books

- (i) Principles of Transportation Engineering by Chakraborty & Das, Prentice Hall, India.
- (ii) Highway Engg by S.K. Khanna & C.E.G. Justo, Nem Chand Bros., Roorkee.
- (iii) Principles and Practice of Highway Engg. by L.R. Kadiyali, Khanna Publishers, Delhi.
- (iv) Principles of Transportation and Highway Engineering by G.V. Rao, Tata McGraw-Hill Publishing Co. Ltd. N. Delhi.
- (v) Alternative Materials in Road Construction by P. T. Sherwood, Thomas Telford Publication, London
- (vi) Civil Engineering Materials, second edition by Shan Somayaji, Prentice Hall Inc.
- (vii) MORTH Specifications for Road and Bridge Works, IRC Publication.
- (viii) Relevant IRC / IS Codes.

Course Outcomes:

Upon completion of this course, the students will be able to:

1. Make investigations for testing of pavement materials
2. Prepare a report to judge suitability of pavement materials
3. Demonstrate expertise in the granular, bituminous and concrete mix designs

4. Apply the knowledge to construct good quality sustainable roads

MCE4L09 Advanced Transportation Laboratory

L T P/D Total Credit
--442.0

Practical: 40 Marks

Max. Marks: 100

Sessional : 60 Marks

Duration: 3 Hours

Course Objectives:

1. To organize traffic surveys and collect wide variety of traffic data
2. To conduct various standard tests on soil, aggregate and bitumen in order to determine various basic properties
3. To do mix design for GSB, bituminous mixes and concrete
4. To study the structural and functional properties of road

Course Content:

Traffic Surveys: Volume count, Speed study, Parking study, Intersection turning movements, Speed and Delay study, Traffic noise measurement, Vehicle emission testing, Roadside and Household interviews, Pavement evaluation, Mix Design: Granular Sub-base, Bituminous Mixes, Cement concrete Mixes, NDT tests Mini project report based on field and laboratory studies

References:

1. Khanna S. K., Justo C.E.G, &Veeraragavan A., Highway Materials and Pavement Testing, Nem Chand and Bros., Roorkee, 2013.
2. Kadyali, L.R., Traffic Engineering and Transport Planning, Khanna Publication, Delhi, 2011.
3. Relevant IRC Codes

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

1. conduct the various traffic surveys
2. perform roadside and household interviews
3. carry out mix design for the CC pavement, GSB, Bituminous mixes, etc.
4. can do the performance evaluation of pavement

MCE4C02 Pavement Analysis and Design

L T P/D Total Credit
3- - 33.0

Max. Marks: 100
Theory: 50 Marks
Sessional : 50 Marks
Duration: 3 Hours

Course Objectives:

1. To study the behaviour of pavements under various loads
2. To study the pavement design factors
3. To design the flexible pavements using different approaches
4. To design the rigid pavement slab and Joint design as per IRC

Course Content:

Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airfield pavements, Stresses in Pavements: Flexible pavement - Layered system concepts, Stress solution for one, two and three layered systems, Fundamental design concepts. 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. Flexible Pavement Design: Empirical, semi-empirical and theoretical approaches, design of highway pavements by IRC Methods, Mechanistic –Empirical design, applications of pavement design software 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 Rigid Pavement Design: Types of joints and their functions, joint spacing; design of CC pavement for roads and highways as per IRC, design of joints. Pavement Evaluation and Rehabilitation: Methods of structural evaluation: overlay design

Recommended Books

1. Yoder and Witczak, Principles of Pavement Design, John Wiley and Sons
2. Yang. H. Huang, Pavement Analysis and Design, Second Edition, Prentice Hall Inc.
3. Rajib B. Mallick and Tahar El-Korchi, Pavement Engineering – Principles and Practice, CRC Press (Taylor and Francis Group)
4. W.Ronald Hudson, Ralph Haas and Zeniswki , Modern Pavement Management, Mc Graw Hill and Co
5. Relevant IRC Codes

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

1. analyze the stresses, strains and deflections in rigid and flexible pavements
2. evaluate pavement design factors
3. design flexible pavements
4. design rigid pavement slab and joints

MCE4C04 Pavement Construction, Maintenance and Management

L	T	P/D	Credits	Max Marks	: 100
3	-	-	3.0	Theory	: 50 Marks
				Sessional	: 50 Marks
				Duration	: 3 Hours

Course Objectives:

1. To understand the construction aspects of pavements
2. To learn about pavement distresses and their maintenance & management
3. To understand the functioning of road construction machinery
4. To know relevant IRC / MoRTH specifications for pavement construction, maintenance and management

Course Contents:

Construction of non-bituminous pavements: Construction of embankment / subgrade. Granular Subbase. Lime & Cement Stabilised sub base / base. Construction of GSB, WBM and WMM.

Construction of bituminous pavements: Prime coat, tack coat, seal coat and surface dressing. Construction of BUSG, premix carpet, BM, DBM and BC, Mastic asphalt. Stone Matrix Asphalt, Quality Control. Re-cycled pavements. Warm mix & cold mix technologies.

Brief coverage of machinery for construction of roads: Machinery for earthwork, granular, bituminous and concrete roads. Rollers, Hot-mix plant, mechanical paver or finisher. Various IRC and MORTH specifications.

Construction of cement concrete pavements: DLC, PQC, Quality Control, Fixed form and Slip-form paving, Joints in cc pavements, IRC and MORTH specifications.

Pavement maintenance & management: Pavement distresses. Maintenance operations. Maintenance of bituminous and cement concrete pavements. Functional condition evaluation of pavements- Roughness, Skid Resistance. Structural evaluation of pavements - non destructive testing, Benkelman beam and Falling Weight Deflectometer.

Pavement Management Systems- Components, structure, data requirements, Project level and Network level needs, Pavement performance prediction - concepts, modelling techniques. Life cycle costing.

Recommended Books

- (i) Principles of Transportation Engineering by Chakroborty & Das, Prentice Hall, India.
- (ii) Highway Engg by S.K. Khanna & C.E.G. Justo, Nem Chand Bros., Roorkee.
- (iii) Principles and Practice of Highway Engg. by L.R. Kadiyali, Khanna Publishers, Delhi.
- (iv) Principles of Transportation and Highway Engineering by G.V. Rao, Tata McGraw-Hill Publishing Co. Ltd. N. Delhi.
- (v) Prithvi Singh Kandhal, Bituminous Road Construction in India, PHI Learning Pvt. Ltd., Delhi.
- (vi) MORTH Specifications for Road and Bridge Works, IRC Publication.

Course Outcomes:

Upon completion of this course, the students will be able to:

1. Make investigations for pavement construction in an area
2. Prepare a document for construction / maintenance / management process for a pavement
3. Demonstrate expertise in the construction of granular / bituminous / CC pavements
4. Apply the knowledge to construct, maintain and manage good quality roads

MCE4L10 Computational Laboratory

L T P/D Total Credit
--442.0

Practical: 40 Marks

Max. Marks: 100

Sessional : 60 Marks

Duration: 3 Hours

Course Objectives:

1. To learn the highway alignment software
2. To get an knowledge on pavement analysis and design software
3. To understand rate analysis for various road related items

Course Content:

Exposure to various Transportation Related Software like
MX Road,
KENPAVE,
IITPAVE etc.
Rate Analysis by MORTH software

References:

1. Software Manuals
2. IITPAVE
3. MX ROAD
4. MoRTH Rate Analysis spreadsheets

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

1. use highway alignment software
2. design the flexible and rigid pavements using different approaches
3. Carryout cost analysis of various items used in Highway construction

MCE4E31 Numerical Methods and Applied Statistics

L	T	P/D	Credits	Max Marks	: 100
3	-	-	3.0	Theory	: 50 Marks
				Sessional	: 50 Marks
				Duration	: 3 Hours

Course Objectives:

1. To learn the different numerical techniques
2. To know the concepts of linear programming
3. To be introduced to the fundamentals of probability
4. To be introduced to the sampling theory
5. To know the concepts of regression

Course Content:

Linear system – Gaussian elimination and Gauss – Jordan methods – matrix inversion – Gauss seidel method – Nonlinear equations – Regula falsi and Newton- Raphson methods – interpolation – Newton’s and Lagrange’s interpolation Linear Programming – Graphical and Simplex methods – Big-M method - Two phase method - Dual simplex method - Dual theory – Sensitivity analysis – Integer programming – Transportation and Assignment problem. 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.

Recommended Books

1. Bowker and Liberman, Engineering Statistics, Prentice-Hall, 1972.
2. Venkatraman, M.K., Numerical Methods in Science and Engineering, National Publisher Company.
3. M.K. Jain, S.R.K. Iyengar and R.K.Jain Numerical Methods for scientific and engineering computation, 5th edition, New Age International (p) Limited, 2007.
4. Hamdy A. Taha, Operations Research: An introduction, 8TH edition, Pearson Prentice Hall, 2007. 5. S. C. Gupta, Fundamentals of Statistics, Himalaya Publishing House, Seventh Revised Edition, 2009.
6. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, Eleventh Revised Edition.

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

1. apply the different numerical techniques to transportation problems
2. use sampling distribution methods for performing several tests
3. use regression and correlation analysis to process transportation data.
4. Use the concepts of time series analysis

MCE4E32 Transportation Planning

L	T	P/D	Credits	Max Marks	: 100
3	-	-	3.0	Theory	: 50 Marks
				Sessional	: 50 Marks
				Duration	: 3 Hours

Course Objectives:

1. To understand the concepts of transportation planning
2. To learn the use of different models of transportation planning
3. To understand the relationship between land use and travel demand
4. To have the knowledge of various types of MRTS

Course Contents:

TRANSPORT PLANNING PROCESS : Status of transportation in India. Urban, regional and national transport planning. Transport planning process, various stages. Study area. Zoning. O-D surveys.

TRIP GENERATION: Trip purpose. Factors affecting trip generation. Trip generation estimation by linear regression analysis, brief review of category analysis,

TRIP DISTRIBUTION: Methods of trip distribution. Basic concepts of uniform factor method, average factor method and opportunity model. Trip distribution by gravity model.

TRAFFIC ASSIGNMENT: All or nothing assignment. multipath assignment, capacity restraint assignment. Route-choice behavior. User Equilibrium assignment- System optimum assignment- Incremental assignment-Stochastic user equilibrium assignment- Dynamic Assignment.

MODAL SPLIT: General considerations for modal split. Factors affecting modal split. Brief introduction to various methods of modal split.

LANDUSE TRANSPORTATION MODELS – Urban forms and structures - Location models -Accessibility – Landuse models - Lowry derivative models – Micro level Planning-

MASS RAPID TRANSIT SYSTEMS: Problems of Urban Transport. Introduction to MRTS. Requirements of MRTS. Types of MRTS. MRTS in India

Recommended Books

- (i) Traffic Engg and Transport Planning by L.R.Kadiyali, Khanna Publishers, Delhi.
- (ii) Introduction to Transport Planning by Bruton, M.J., Hutchinson Technical Education, London.
- (iii) Principles of Urban Transport Systems Planning by Hutchinson, B.G., Scripta, McGrawHill, New York.
- (iv) Transportation Engineering - An Introduction by Khisty C.J., Prentice Hall, NJ
- (v) Principles of Transportation Engineering by Chakroborty & Das, Prentice Hall, India.
- (vi) Transportation Engineering & Planning by Papacostas C.S. and Prevedouros, P.D., PHI, New Delhi.

Course Outcomes:

Upon completion of this course, the students will be able to:

1. Make investigations for transportation planning of an area
2. Prepare a document for a suitable transportation planning process for an area
3. Demonstrate expertise in the application of various transportation planning models
4. Apply the knowledge to forecast travel demand and suggest a suitable transportation plan

MCE4E33 Transportation Drainage System

L	T	P/D	Credits	Max Marks	: 100
3	-	-	3.0	Theory	: 50 Marks
				Sessional	: 50 Marks
				Duration	: 3 Hours

Course Objectives:

1. To understand importance of drainage in highways
2. To know about surface and subsurface drainage
3. To understand hydrologic and hydraulic analysis
4. To understand issues related to high ground water table

Course Content:

Importance of drainage, Types of Road Drainage, General Criterion for Road Drainage Systems of Drainage: Surface and sub-surface drainage systems, Internal drainage of pavement structure, components of surface drainage system, surface drains, road side drains, catch water drains, geometric design of road, hydraulic design of drains, shoulder drainage, drainage layer, subsurface drainage with transverse drains, horizontal drains, sub surface drain in heavy clayey soil, sub surface drain at valley curve / change of grade, capillary cut-off.

Design of surface drainage and subsurface drainage system: Hydrologic analysis, hydraulic analysis, data for drainage design, design steps, Cross Drainage, Sub surface drainage, lowering of water table, control of seepage flow, control of capillary rise, design of filter material, drainage of slopes and erosion control, road construction in water logged areas. Drainage in hill roads

Recommended Books

1. Highway Engg by S.K.Khanna& C.E.G. Justo, Nem Chand Bros., Roorkee.
2. Principles and Practice of Highway Engg. by L.R.Kadiyali, Khanna Publishers, Delhi.
3. Rural Roads Manual, IRC SP-20 2002
4. IRC SP 042: Guidelines on Road Drainage (First Revision), Indian Roads Congress, 2014
5. IRC SP 050: Guidelines on Urban Drainage (First Revision), Indian Roads Congress, 2013

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

1. Appreciate importance of drainage for highways
2. Estimate surface runoff for drainage purpose
3. Hydraulic design of drains
4. Take remedial steps in typical situations such as construction in water logged area/ erosion related problems

MCE4E34 Public Transportation

L	T	P/D	Credits	Max Marks	: 100
3	-	-	3	Theory	: 50 Marks
				Sessional	: 50 Marks
				Duration	: 3 Hours

Course Objectives:

1. To know various modes of public transportation
2. To understand the estimation of transit demand and identification of transit corridor
3. To learn to develop an efficient stop policy and efficient schedule
4. To study case studies of MRTS

Course Content:

Modes of public transportation and application of each to urban travel needs

Transit system operations, para-transit systems, street transit systems, rapid transit systems, Estimation of transit demand, route development, properties of a good route set, determination of a good route set, stop location and stopping policy, schedule development, properties of a good schedule, determination of a good schedule.

Capacity of rapid transit systems, line capacity of RTS, capacity of street transit systems.

Transit corridor, identification and planning, mass transport management measures, integration of public transportation modes. Public transport infrastructure, case studies, multi mode transportation system.

Planning for public transport, fares and subsidies.

Intermediate Public Transport in Indian Cities, types of IPT vehicles, Characteristics of IPT modes.

Recommended Books:

- (i) Traffic Engg. And Transport Planning *by* L.R.Kadiyali, Khanna Publishers, Delhi.
- (ii) Introduction to Transport Planning *by* Bruton, M.J., Hutchinson Technical Education, London.
- (iii) Principles of Transportation Engineering *by* Chakroborty & Das, Prentice Hall, India.

Course Outcomes:

Upon completion of this course, the students will be able to:

1. Make investigations for public transportation in an area
2. Prepare a report for a suitable transit system for an area
3. Apply the knowledge to estimate the transit demand and identify the transit corridor
4. Demonstrate expertise in deciding an efficient schedule for the transit system

MCE4E35 Transportation Systems Planning & Design

L	T	P/D	Credits	Max Marks	: 100
3	-	-	3	Theory	: 50 Marks
				Sessional	: 50 Marks
				Duration	: 3 Hours

Course Objectives:

1. To understand various components of Permanent way
2. To be familiar with the geometric design of railway tracks
3. To learn the concepts of airport planning and demand forecasting
4. To understand the geometrics design of the airfield
5. To understand pavement design of airports

Course Content:

Permanent-way and its components, Track and Track Stresses, Geometric Design of Track, Curves and Superelevation, Points and Crossings, Track Maintenance, Modernization of Railways and High Speed Trains

Forecasting Air Transport Demand, Characteristics of Aircraft as They Affect Airports, Airport Capacity, Airside Configuration and Geometric Design of the Airside, Airport Drainage and Pavement Design

Waterways: Introduction, Economic significance

Recommended Books:

1. M.M. Agarwal, Railway Engineering, Prabha& Co. 2007.
2. Oza and Oza, Elements of Dock and Harbour Engineering, Charotar Publishing House, 1996.
3. Geoffrey D. Gosling; Airport ground access mode choice models, Transportation Research Board, Washington, D.C., 2008
4. Norman J. Ashford, Saleh Mumayiz, Paul H. Wright; Airport Engineering Planning, Design, and Development of 21st century Airports, John Wiley & Sons, Inc.,2011
5. Horonjeff, R., McKelvey, F. X., Sproule, W. J., and Young, S. B. Planning and Design of Airports, Fifth Edition, McGraw-Hill, New York, USA, 2010.
6. Young, S. B., and Wells, A. T. Airport Planning and Management, Sixth Edition, McGraw-Hill, New York, USA, 2011.
7. Khanna, S. K., Arora, M. G., and Jain, S. S. Airport planning and Design, Sixth Edition, Nem Chand and Bros, Roorkee, India, 2012.

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

1. understand the various components of permanent way
2. carryout geometric design of railway tracks
3. design the various components of airports

MCE4E36 Intelligent Transportation Systems

L	T	P/D	Credits	Max Marks	: 100
3	-	-	3.0	Theory	: 50 Marks
				Sessional	: 50 Marks
				Duration	: 3 Hours

Course Objectives:

1. To learn the fundamentals of ITS
2. To understand the different types of sensors
3. To study the ITS functional areas
4. To have an overview of ITS implementation in developing / developed countries

Course Content:

Introduction to Intelligent Transportation Systems (ITS) – Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

Telecommunications in ITS – Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Vehicle – Road side communication – Vehicle Positioning System

ITS functional areas – Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS).

ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.

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, Case studies.

Recommended Books:

1. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
2. Sussman, J. M., Perspective on ITS, Artech House Publishers, 2005.
3. National ITS Architecture Documentation, US Department of Transportation, 2007 (CDROM).
4. Chowdhary, M.A. and A Sadek, Fundamentals of Intelligent Transportation systems planning. Artech House Inc., US, 2003.
5. Williams, B., Intelligent transportation systems standards. Artech House, London,2008.

Course Outcomes:

Upon completion of this course, the students will be able to:

1. understand the sensor technologies
2. understand the communication techniques
3. apply the various ITS methodologies

4. understand the user needs
5. demonstrate mastery of ITS to solve practical problems

MCE4E37 Transportation Economics and Finance

L	T	P/D	Credits	Max Marks	: 100
3	-	-	3.0	Theory	: 50 Marks
				Sessional	: 50 Marks
				Duration	: 3 Hours

Course Objectives:

1. To learn about transportation cost.
2. To understand the vehicle operating cost
3. To familiarize with the formulation of project alternatives and applying the economic analysis methods
4. To understand the principles and procedure of financing of road 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. Financing of road projects - methods – Private Public Partnership (PPP) - Toll collection - Economic viability of Design-Build-Operate-Transfer Schemes – Risk Analysis – Value for Money analysis - Case Studies.

Recommended Books:

1. Winfrey, Economic analysis for Highways, International Textbook Company, Pennsylvania, 1969.
2. CRRI, Road User Cost Study in India, New Delhi, 1982
3. IRC, Manual on Economic Evaluation of Highway Projects in India, SP30, 2007

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

1. understand the concepts of decision making
2. estimate vehicle operation cost and accident cost
3. perform economic analysis of a transportation project
4. apply various financing methods in road projects

MCE4E38Geo-Informatics in Transportation Engineering

L	T	P/D	Credits	Max Marks	: 100
3	-	-	3.0	Theory	: 50 Marks
				Sessional	: 50 Marks
				Duration	: 3 Hours

Course Objectives:

1. To learn the basic concepts of geo-informatics (GIS, RS and GPS) in brief
2. To understand these basic concepts in context of transportation and transportation networks.
3. To learn the data needs and database development for doing transportation analysis in GIS environment.
4. To understand the concepts of transportation networks and algorithms and how they are incorporated into GIS.
5. To understand how GIS processes can be used for efficient transportation modeling and analysis.
6. To understand various applications of GIS in Transportation (GIS-T) including Intelligent Transport Systems (ITS) and learn from some case studies.

Course Content:

Concept of GIS, GPS and RS; land use and transportation data; database development; Map Generation and Analysis, Concept of map layers. Land cover analysis; transportation network development and algorithms; Network development and management, Network properties. Shortest path algorithms, Transit network and paths. Transportation models and their applications in GIS; GIS applications in transportation; GIS in highway management, GIS in traffic modelling, GIS in accident analysis, GIS in route planning, Intelligent Transport Systems (ITS), Case studies.

Recommended Books:

1. Hensher D. A., Button K. J., Haynes K. E., and Stopher P. R. (Eds.), Handbook of Transport Geography and Spatial Systems, Elsevier, 2004.
2. Thill Jean-Claude, Geographical Information Systems in Transportation Research, Pergamon, 2000.
3. O'sullivan David, Geographic Information Analysis, John Wiley & Sons, 2003.
4. Longley P. A., Barnsley M. J., Donnay Jean-Paul, Remote Sensing and Urban Analysis, Taylor & Francis, 2001.
5. Caliper Corporation, Travel Demand Modelling with TransCAD, 1998.
6. Michael W., GIS - A Computing Perspective, CRC Press, 2004.

Course Outcomes: Upon completion of this course, the student will be able to:

1. understand application of GIS and RS in Transportation Engineering
2. understand map generation and its analysis
3. develop transportation network
4. understand Role of GIS in Land Use and Transport Planning

MCE4E39 Financing Transportation Projects

L	T	P/D	Credits	Max Marks	: 100
3	-	-	3.0	Theory	: 50 Marks
				Sessional	: 50 Marks
				Duration	: 3 Hours

Course Objectives:

1. To understand the fundamentals of financing a transportation project
2. To learn the concept of PPP and its application
3. To learn about the concession design & award
4. To acquaint with risk management of infra projects
5. To understand the project finance and its viability

Course Contents:

Infrastructure Development – Introduction: Definition of infrastructure; Multiplier effects of infrastructure development on economic development of the nation. Sources of financing infrastructure projects: Traditional and private investments; Various financial instruments. Limitations of traditional procurement system of infrastructure; Legal frameworks and Incentives for private sector participation in infrastructure development

Public Private Partnerships – Procurement Process: Introduction to infrastructure development through PPP route; Benefits of PPP mode of procurement; Types of PPP Models and their contractual structure. Stakeholders' perspectives: Granting authority, Funders and Concessionaire. Government's role in successful PPP projects. Financial and Economic Appraisal of BOT Projects; VFM evaluation. PPP procurement process; Lifecycle of PPP projects. Contractual package of PPP project; Bankable concession agreement. Case study – Procurement process of Indian PPP projects.

Concession – Design and Award: Introduction to concession design and award. Concession Design: Price setting; Price adjustment; Specific performance targets; Penalties and bonuses; Public parties' security rights; Duration, termination, and compensation; Force majeure and other unforeseen changes; Dispute settlement. Concession Award: Competitive bidding; Direct negotiations and unsolicited proposals; Competitive negotiations; Prequalification and unsolicited proposals; Competitive negotiations; Prequalification and short-listing; Bid structure and evaluation; Bidding rules and procedures. Case study – Model concession agreements of highways projects in India.

Risk Management of Infrastructure Projects: Risks associated with various infrastructure projects; Introduction to risk management concept. Risk analysis techniques. Risk mitigation strategies. Risk allocation frameworks of major infrastructure projects procured through various PPP modes. Computer-based approach to risk management in infrastructure finance. Case study – Risk allocation frameworks of Indian PPP projects.

Project Finance: Introduction to project financing concept. Analysis of project viability. Designing security arrangements. Preparing the project financing plan. Case study – Financial structure and infrastructure project finance : the Hong Kong Western Harbour Crossing.

Credit Rating of Infrastructure Projects: Introduction to credit rating of infrastructure projects and role of credit ratings in financing infrastructure projects. Rating frameworks of various national and international credit rating agencies for infrastructure projects in various sectors.

References:

1. Akintoye,A.,Beck, M.,&Hardcastle, C.(Eds.).(2003).Public-Private Partnerships - Managing risks and opportunities. Oxford:Blackwell Science Limited.
2. Finnerty, J. D.(1996).Project financing - Asset-based financial engineering. New York: John Wiley & Sons, Inc.
3. Merna, T.,&Njiru, C.(2002). Financing infrastructure projects (First ed.). London: Thomas Telford.
4. Nevitt,P.K.,&Fabozzi, F. J.(2000).Project financing (7 ed.). London, UK:Euromoney Books.
5. Raghuram, G., Jain, R.,Sinha,S.,Pangotra,P.,&Morris,S.(2000). Infrastructure Development and Financing: Towards a Public-Private Partnership: MacMillan.
6. Tinsley, R.(2002).Project Finance in Asia Pacific:Practical Case Studies. London, UK: Euromoney Books.
7. UNIDO.(1996). Guidelines for infrastructure development through Build-Operate-Transfer (BOT) projects.Vienna: UNIDO.
8. Walker, C.,&Smith,A. J.(1995).Privatized infrastructure: the Build Operate Transfer approach. London: Thomas Telford.
9. Yescombe,E. R.(2002).Principles of Project Finance. California:Academic Press.
10. Kurowski, L.,&Sussman, D.(2011). Investment project design - A guide to financial and economic analysis with constraints. New Jersey: John Wiley & Sons.
11. Pretorius, F., Lejot,P., McInnis,A.,Arner, D.,&Hsu,B. F.-C.(2008).Project finance for construction and infrastructure:Principles and case studies. Oxford:Blackwell Publishing.
12. Weber,B.,&Alfen, H. W.(2010). Infrastructure as an asset class - Investment strategies, project finance and PPP. West Sussex: John Wiley & Sons

Course Outcomes:

Upon completion of this course, the students will be able to:

1. Make investigations for financing a transportation project
2. Prepare a document for PPP procurement process
3. Demonstrate expertise in evaluating risks associated with an infra project and their management
4. Apply the knowledge to decide beneficially the financing of an infra project

MCE4E40 Project Management

L	T	P/D	Credits	Max Marks	: 100
3	-	-	3.0	Theory	: 50 Marks
				Sessional	: 50 Marks
				Duration	: 3 Hours

Course Objectives:

1. To learn about man power planning and estimation of equipment cost
2. To understand project planning and scheduling concepts
3. To know the types of construction contracts and their drafting
4. To understand Public Private Partnership concept

Course Content:

Time Estimates: Earliest Expected Time, Latest allowable occurrence time, slack time, Earliest start time, Earliest finish time, Latest start time, latest finish time.

Network Scheduling: Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), Precedence diagram technique (PDM)

Cost Optimization: cost slope, crashing critical path, Optimum duration.

Updating: Introduction, examples, when to update

Resource allocation: Introduction, resource smoothing, resource levelling, Line of Balancing technique (LOB). Resource Based Network.

Linear Programming and critical path scheduling: Introduction, standard form, formulation by linear programming, transportation model, method of solution, fictitious cost method, Linear programming and critical path.

Recommended Books:

1. Dharwadkar, P.P., Management in Construction Industry, Oxford IBH, New Delhi, 1992.
2. Patrick, C., Construction Project Planning and Scheduling, Pearson, 2012.
3. Brien, J.O. and Plotnick, F.L., CPM in Construction Management, Mcgraw Hill, 2010.
4. Punmia, B.C., and Khandelwal, K.K., Project Planning and control with PERT and CPM, Laxmi Publications, 2002.

Course Outcomes: Upon completion of this course, the student will be able to:

1. Estimate the man power requirement and can recruit suitable candidates for construction jobs
2. Analyse and compare the cost estimates of different construction equipment
3. Compute construction schedules, network diagrams and time estimates of projects
4. Understand concept of PPP in various development projects

MCE4O71/72 Road Safety and Environment

L	T	P/D	Credits	Max Marks	: 100
3	-	-	3	Theory	: 50 Marks
				Sessional	: 50 Marks
				Duration	: 3 Hours

Course Objectives:

1. To know causes, characteristics and statistics of road accidents
2. To understand the planning and design of roads for safety
3. To learn to design a suitable type of road junction for safety
4. To understand the concept of road safety audit
5. To learn about vehicular pollution and its control

Course Content:

Trends in roads development, Problem of road accidents, Characteristics of road accidents, Causes of accidents, Global and Indian Road Safety Scenario, Factors responsible for success stories in Road Safety.

Planning of Roads for Safety: Land Use Planning and Zoning, Development control and encroachment, Network hierarchy, Route planning through communities. Access control, Traffic segregation, Traffic calming.

Designing for Safety: Road link design, Alignment design, Cross-sectional elements, Junction design basic principles, selection of junction type, Factors affecting safety at various Junction types, Provisions for vulnerable road users.

Road Safety Audit: Concepts of Road Safety Audit, Road Safety auditors & key personnel in RSA, Example and commonly identified issues during RSA, Road Safety Audit report, Accident investigation and prevention, Basic strategies for accident reduction, Selection of countermeasures, Non-Engineering measures for Road Safety, Legal framework for Road Safety.

Transport related pollution, noise pollution, air pollution, effects of weather conditions, vehicular emission parameters, pollution standards. Fuel crisis and transportation, factors affecting fuel consumption, fuel economy in various modes of transportation, various types of alternative fuels.

Books recommended:

- (i) Traffic Engg and Transport Planning by L.R. Kadiyali, Khanna Publishers, Delhi.
- (ii) Highway Engg by S.K. Khanna & C.E.G. Justo, Nem Chand Bros., Roorkee.
- (iii) Trainers Road Safety Manual, NHA and Ministry of Shipping, Road Transport and Highways, Govt of India.
- (iv) Relevant IRC codes

Course Outcomes:

Upon completion of this course, the students will be able to:

1. Make investigations to know the causes of road accidents and suggest remedial measures
2. Apply the knowledge to plan and design safe roads
3. Prepare a report for road safety audit
4. To judge adverse effects of transport pollution and suggest remedial measures.