Curriculum
2021

M. Tech.
Transportation Engineering

(Duration of Study : 2 years)

GMRIT
Training Tomorrow's
Engineers Today

Department of Civil Engineering
GMR Institute of Technology
Rajam, Andhra Pradesh
(An Autonomous Institute Affiliated to JNTU Kakinada, AP)
NBA Accredited and NAAC Accredited

Department of Civil Engineering -Transportation Engineering

[Minimum Credits to be earned: 68]

No	Course Code	Course	POs	Periods			
				L	T	P	C
First Semester							
1	21MEX101	Advanced Optimization Techniques		4	-	-	4
2	21TRE102	Pavement Materials and Characterization		4	-	-	4
3		Elective I		4	-	-	4
4		Elective II		4	-	-	4
5		Elective III		4	-	-	4
6	21TRE103	Highway Material Characterizations and Traffic Lab		-	-	3	1.5
7	21TRE104	Term Paper		-	-	3	1.5
			Total	**20**	**-**	**6**	**23**
Second Semester							
1	21TRE201	Pavements Design and Evaluation		4	-	-	4
2	21TRE202	Highway Project Formulation and Economics		4	-	-	4
3		Elective IV		4	-	-	4
4		Elective V		4	-	-	4
5		Elective VI		4	-	-	4
6	21TRE203	Highway Numerical Analysis Lab		-	-	3	1.5
7	21TRE204	Comprehensive Viva		-	-	3	1.5
			Total	**20**	**-**	**6**	**23**
Third Semester							
1	21TRE301	Internship		-	-	-	4
2	21TRE302	Project		-	-	-	-
3		Research Methodology and IPR (Audit Course)		-	-	-	0
			Total			-	4
Fourth Semester							
1	21TRE302	Project		-	-	-	**18**

List of Elective Courses

No	Course Code	Course	POs	Periods L	T	P	C
Elective I							
1	21TRE001	Traffic Engineering and Management		4	-	-	4
2	21TRE002	Road Safety Analysis		4	-	-	4
3	21TRE003	Rural Roads Planning and Design		4	-	-	4
Elective II							
1	21TRE004	Intelligent Transport Systems		4	-	-	4
2	21TRE005	Ground Improvement Techniques		4	-	-	4
3	21TRE006	Construction Technology and Equipment		4	-	-	4
Elective III							
1	21TRE007	Airport, Railway and Harbor Engineering		4	-	-	4
2	21TRE008	RS and GIS for Transportation Engineering		4	-	-	4
3	21TRE009	Road Projects		4	-	-	4
Elective IV							
1	21TRE010	Urban Transportation Planning		4	-	-	4
2	21TRE011	Transportation Systems Design		4	-	-	4
3	21TRE012	Smart Cities		4	-	-	4
Elective V							
1	21TRE013	Special Problems in Road Construction		4	-	-	4
2	21TRE014	Land Use and Transport Modeling		4	-	-	4
3	21TRE015	Pavement Management Systems		4	-	-	4
Elective VI							
1	21TRE016	Sustainable Highway Practices		4	-	-	4
2	21TRE017	Bridge Engineering		4	-	-	4
3	21TRE018	Advanced Traffic Analysis		4	-	-	4

21MEX101 Advanced Optimization Techniques

4 0 0 4

Course Outcomes

1. Design of mechanical systems and interdisciplinary engineering applications and business solutions using suitable optimization technique
2. Apply numerical or iterative techniques in power systems for optimal power flow solutions
3. Optimize the parameters in control systems for desired steady state or transient response
4. Optimize the cost function in deciding economic factors of power systems
5. Design of electrical systems optimally using suitable techniques like univariate method, steepest descent method etc
6. Design of electrical systems optimally using, steepest and descent method etc.

Unit I

Linear programming and Assignment Problem

Linear programming-Two-phase simplex method, Big-M method, duality, interpretation, applications. Assignment problem- Hungarian's algorithm, Degeneracy, applications, unbalanced problems traveling salesman problem.

Applications of assignment problems **15 Hours**

Unit II

Classical and Numerical Optimization Techniques

Classical optimization techniques-Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method Lagrange multipliers, Kuhn-Tucker conditions. Numerical methods for optimization-Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, types of penalty methods for handling constraints.

Exterior penalty function method for handling constraint **15 Hours**

Unit III

Genetic algorithm and Programming

Genetic algorithm (GA) -Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA. Genetic Programming (GP)- Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

Solving differential equations using GP **15 Hours**

Unit IV

Multi-Objective GA

Multi-Objective GA-Pareto's analysis, non-dominated front, multi – objective GA, Nondominated sorted GA, convergence criterion, applications of multi-objective problems. Basic Problem solving using Genetic algorithm, Genetic Programming & Multi Objective GA and simple applications of optimization for engineering systems.

Simple applications of optimization for engineering systems **15 Hours**

Total: 60 Hours

Textbook (s)

1. Arora, J. S., Introduction to Optimum Design, McGraw Hill International Education, New York, 1989.
2. Deb, K., Optimization for Engineering Design: Algorithms and Examples, 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 1995.
3. Rao, S.S., Engineering Optimization: Theory and Practice, New Age International (P) Ltd., New Delhi, 2001.

Reference(s)

1. Goldberg, D. E., and Edward, D., Genetic Algorithms in Search and Optimization, Addison-Wesley Publishing Company, USA, 1990.
2. Koza, J. R., and Rice, J. P., Genetic Programming: on the programming of Computers by means of Natural Selection, Bradford,1993.
3. Deb, K., Multi-Objective Optimization Using Evolutionary Algorithms, Wiley, 2001

21TRE102 Pavement Materials and Characterization

4 0 0 4

Course Outcomes

1. Assess the suitability of aggregates used in various layers of pavement as well as the bitumen used in the wearing course.
2. Demonstrate the utility of various bitumen products.
3. Determine the optimum bitumen content by applying the bitumen mix design methods.
4. Prioritize the sequential stages involved in the construction of flexible and bituminous pavements
5. Decide the kind of equipment needed for the construction of road and its operation etc.
6. Test the quality of pavement layers in flexible and rigid pavements.

Unit I
Subgrade Soil Characterization
Properties of subgrade layers; different types of soils, Mechanical response of soil; SPT, DCPT, CPT, CBR, Plate Load test & resilient modulus; Field compaction and control. Dynamic properties of soil: FWD test.
Soil gradation, Shear test, Stabilization **15 Hours**

Unit II
Aggregate Characterization
Origin, Classification, Types of aggregates; Sampling of aggregates; Mechanical and shape properties of aggregates, Aggregate texture and skid resistance, polishing of aggregates; Proportioning and Blending of aggregates: Super pave gradation, Fuller and Thompson's Equation, 0.45 power maximum density graph; Use of locally available materials in lieu of aggregate.
Maximum aggregate size, NMSA, gradation – design **15 Hours**

Unit III
Bitumen & Bituminous Concrete Mixes
Chemistry of bitumen, Rheology of bitumen, Elastic modulus, Dynamic modulus, visco-elastic and fatigue properties, creep test, stiffness modulus of bitumen, long term and short-term ageing Desirable properties of bituminous mixes, Design of bituminous mixes: Modified Marshall's specifications, Introduction to super pave mix design.
Chemical constitution, Cutback, Tar **15 Hours**

Unit IV
Cement and Concrete Mixes
Types of cements and basic cement properties, Special cements; Quality tests on cement; Introduction to advanced concretes like self-compacted concrete, Light weight concrete, Roller Compacted Concrete for pavement application; Nano technology applications in cement concrete.
Composition of cement, Gradation, mix design **15 Hours**

Total: 60 Hours

Text Book(s)

1. Khanna, S.K., and Justo, C.E.G., Highway Engineering, 9th Edition, Nem Chand and Bros. Roorkee, 2011.
2. Das, A. And Chakroborty, P. Principles of Transportation Engineering, 1st Edition, PHI Learning Pvt Ltd., 2012.

Reference(s)

1. Atkins, N. Harold, Highway Materials, Soils and Concretes, Fourth Edition, 2002, Prentice-Hall.
2. Kerbs Robert D. and Richard D. Walker, Highway Materials, McGraw-Hill, 1971.

21TRE103 Highway Material Characterizations and Traffic Lab

0 0 3 1.5

Course Outcomes

1. Identify different pavement evaluation techniques.
2. Understand the various quality control tests done on aggregates.
3. Understand the various tests done on soil for using a pavement construction material
4. Understand various aging tests on bitumen for performance of binder
5. Knowledge on performance of bituminous mixes from rutting and stiffness parameters
6. Evaluation of signalized and unsignalized intersections using simulation techniques

Aggregates

Aggregates Sampling, Gradation- Shape tests- Elastic recovery - Aggregate Impact Test- Los Angeles Abrasion Test – Crushing strength of Aggregates- Specific Gravity Test and Water Absorption Test - bulking of sand.

Bitumen & Bituminous Mixes

Penetration Test -Ductility Test- Elastic recovery- Softening point test - Viscosity test - Marshall Mix Design- Binder content determination.

Soil

Gradation-dry and wet-Hydrometer Analysis- CBR Test, Soil stabilization.

Traffic studies

Traffic volume, speed, parking

21TRE201 Pavements Design and Evaluation

4 0 0 4

Course Outcomes

1. Identify the factors affecting pavement design and their importance.
2. Analyse the stresses and strains in a flexible pavement using multi-layered elastic theory.
3. Analyse stresses and strains in a rigid pavement using Westergaard's theory.
4. Design a Flexible pavement using IRC, Asphalt Institute, and AASHTO methods.
5. Design a Rigid pavement using IRC, and AASHTO methods.
6. Understand various techniques adopted for pavement surface condition evaluation.

Unit I
Introduction to Pavement Engineering
Functions of Pavements; Types of Pavements: Flexible, Rigid, Composite Pavements; Variables Considered in Pavement Design: Material Characteristics, Factors related to Axle and Wheel Loads, Concept of Equivalent Single Wheel Load (ESWL).
IRC Traffic Loading Classifications, Traffic Volume **15 Hours**

Unit II
Stresses and Strains
Stresses and Strains: Stresses and Strains in Flexible Pavement using: Single layer and Double layer theory; Stresses and Strains in Rigid Pavement for: Wheel Load, Temperature and Friction.
Sustainable Pavement Materials, Three-layer theory. **15 Hours**

Unit III
Design of Components in Flexible and Rigid Pavement
Overview of IRC design method for Flexible Pavement and Rigid Pavement; Design of Flexible Pavement: Salient features of IRC: 37 (2018), Design of Flexible Pavement using IRC: 37 (2012) guidelines, Design of Rigid Pavement using IRC: 58 (2011) guidelines; Design of Joints in Rigid Pavements: Dowel Bars, Tie Bars.
Semi-Rigid Pavements, Perpetual pavements **15 Hours**

Unit IV
Evaluation of Surface Condition
Methods of measurement of skid resistance, unevenness, ruts and cracks. Pavement surface condition evaluation by physical measurements, their applications. Evaluation by non-destructive tests such as FWD, Benkelman Beam rebound deflection using BBD for flexible overlay design. Road Profiling Van.
LIDAR survey, Area under pavement profile **15 Hours**
Total: 60 Hours

Text Book(s)

1. Yoder, E. J., and Witczak, M. W., Principles of Pavement Design, 2nd Edition, John Willey and Sons, 1975.
2. Khanna, S. K., Justo, C. E. G., and Veeraragavan, A., Highway Engineering, 10th Edition, Nem Chand Brothers publications, 2017.

Reference(s)

1. Huang, Y. H., Pavement Analysis and Design, Prentice Hall Publications, Englewood Cliffs, New Jersey.
2. IRC-37:2018, Guidelines for the Design of Flexible Pavements, Indian Roads Congress,
3. Das, A., and Chakraborty, P., Principles of Transportation Engineering, PHI Learning Pvt, Ltd., New Delhi, 2017,

21TRE202 Highway Project Formulation and Economics

4 0 0 4

Course Outcomes

1. Classify the requirements in project formulation, Non-monetary and monetary, development of cash flow diagrams, Preparation of Project and components in Highway Planning
2. Gain knowledge on DPR components
3. Fundamental knowledge calculation of road user costs methodologies for economic evaluation of accidents
4. Estimate of transportation project feasibility using economic methods.
5. Explain factors affecting environmental impact assessment for highway projects.
6. Understand the concept of project appraisal by shadow pricing

Unit I
Project Formulation
Requirements in project formulation, Criteria fixation, Components of project, non-monetary and monetary Criteria in formulation of project, Decision making Criteria input in Project formulation. Preparation of DPR - Guidelines, Transport Projects and development of cash flow diagrams, Cost and benefit components, Discounting criteria, Preparation of Project, Highway Planning, Traffic infrastructure, Project formulation, Road Network project development. Need for Economic Evaluation; Principles of economic evaluation;
Welfare economics; Social costs, Vest change, Rate of return. **15 Hours**

Unit II
Road user costs
Value of Travel time Savings - Economic concept of evaluation of travel time savings; Issues connected with evaluation of travel time savings. Vehicle operating costs- Components of VOC, Road User Cost study in India; Accident costs; Methodologies for economic evaluation of an accident.
Factors involved, Basic methods of economic analysis. **15 Hours**

Unit III
Basic methods of economic analysis
Equivalent Uniform Annual Cost Method; Present worth of cost method; Equivalent uniform annual net return method; Net present value method; Benefit cost ratio method; Rate of Return Method.; Applications of these methods to highway projects
Net present value, life time cost analysis **15 Hours**

Unit IV
Project appraisal by shadow pricing with case studies
Toll system analysis, financial analysis; Budgeting, Environmental impact assessment: Basic Concepts, Objectives, Transportation Related Environmental Impacts – Vehicular Impacts – Safety and Capacity Impacts – Roadway Impacts – Construction Impacts, Environmental Impact Assessment – Environmental Impact Statement.
Environment Audit, Typical case studies. **15 Hours**

Total: 60 Hours

Text Book(s)

1. Heggie, I. G., Transportation Engineering Economics, Mc Graw Hill Publishers, London, 1972.
2. Winfrey, R., Economic Analysis for Highways, International Textbook Company, 1st edition, 1969

Reference(s)

1. Kadiyali, L. R., Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2000.
2. Road User Cost Study in India, Central Road Research Institute, India, 1982.
3. IRC: SP: 30 - 1993, Manual on Economic Evaluation of Highway Projects in India, IRC Publications, New Delhi.
4. IRC: SP: 19 - 2001, Manual for Survey, Investigation & Preparation of Road Projects, IRC Publications, New Delhi.

21TRE203 Highway Numerical Analysis Lab

0 0 3 1.5

Course Outcomes

1. Perform stress strain analysis of flexible pavements
2. Perform stress strain analysis of rigid pavements
3. Gain knowledge on application of GIS for transportation engineering
4. Understand statistical significance of designing traffic stream elements
5. Apply sampling techniques in traffic stream design
6. Relate statistical distributions process and its application in traffic engineering

List of Experiments

Flexible pavement:

1. IITPAVE: Stress strain analysis and pavement thickness
2. IITKGPBACK: Elastic modulus and overlay design
3. KENPAVE: Stress strain analysis

Rigid pavement:

1. Design of rigid pavement – IRC 58 [2015]

Remote Sensing and GIS:

1. Geo-referencing
2. Digitization
3. Spatial interpolation
4. Digital elevation model preparation

Statistical Techniques:

1. Random numbers generation
2. Chi-square test
3. Regression analysis
4. Analysis of variance [ANOVA]
5. Introduction to WEKA tool

21TRE001 Traffic Engineering and Management

4 0 0 4

Course Outcomes

1. Develop a basic Knowledge of the fundamental issues in traffic engineering.
2. Demonstrate the clear understanding of the factors influencing road vehicle performance.
3. Define the basic principles in highway geometric design and be able to apply these principles to solve simple problems.
4. Conclude the summarization of traffic flow and queuing theory.
5. Define the critical procedures for highway capacity and level of service analysis.
6. Build knowledge on traffic signal theory and elements of traffic signal Operations

Unit I
Traffic Characteristics
Basic traffic characteristics-Speed, volume and concentration. Relationship between Flow, Speed and Concentration Volume Studies- Objectives, Methods; Speed studies- Objectives: Definition of Spot Speed, time mean speed and space mean speed, speed studies, Presentation of speed study data. Density, Head ways and Gaps; Critical Gap; Gap acceptance studies
Speed, flow, capacity **15 Hours**

Unit II
Highway Capacity and Level of Service
Basic definitions related to capacity; Level of service concept; Factors affecting capacity and level of service; Computation of capacity and level of service for two lane highways Multilane highways and freeways. Types of parking facilities- on street parking and off-street Parking facilities; Parking surveys and statistics.
Critical gap, headway level of service **15 Hours**

Unit III
Traffic Safety and Regulations
Accident studies and analysis; Causes of accidents-The Road, The vehicle, the road user and the Environment; Engineering, Enforcement and Education measures for the prevention of accidents. Traffic Signals-Design of Isolated Traffic Signal by Webster method, Warrants for signalization, Signal Co-ordination methods, Simultaneous, Alternate, Simple progression and Flexible progression Systems.
Webster's method, Signals, Traffic control. **15 Hours**

Unit IV
Traffic-Environment-Management
Detrimental effects of Traffic on Environment; Air pollution; Noise Pollution; Measures to curtail environmental degradation due to traffic. Ride sharing and ride hailing, Carpooling, Congestion pricing, one-way streets, Radar speed display, ANPR system.
Toll analysis, Air pollutants, BS codes **15 Hours**

Total: 60 Hours

Text Book(s)

1. Kadiyali, L.R., Traffic Engineering and Transportation Planning, Khanna Publishers, New Delhi, 2016.
2. Khanna, S. K., Justo, C. E. G., and Veeraragavan, A., Highway Engineering, Revised 10th Edition, Nem Chand & Sons Publications, 2017.
3. Jotin Khisty, C., and Kent Lall, B., Transportation Engineering - An introduction, 3rd Edition, Prentice Hall Publications, 2003.

Reference(s)

1. Louis J. Pignataro, and Cantilli, E. J., Traffic Engineering - Theory &Practice, Prentice Hall Publications, 1973.
2. Mannering, F., and Washburn, S. S., Principles of Highway Engineering and Traffic Analysis, 5th Edition, John Wiley & Sons Publications, 2012.

21TRE002 Road Safety Analysis

4 0 0 4

Course Outcomes

1. Analyze the effect of driver characteristics, roadway characteristics, climatic factors on highway safety.
2. Plan and design a road safety improvement program.
3. Analyze accident data and suggest safety measures.
4. Conduct road safety audit.
5. Interpret accident data using statistical analysis.
6. Build knowledge on accident mitigation measures

Unit I
Road Safety Management
Road accidents, Trends, causes, Collision and Condition diagrams, Highway safety, human factors, Vehicle factors, crash vs accident, road safety improvement strategies, elements of a road safety plan.
Safety data needs **15 Hours**

Unit II
Statistical Analysis of Crash Data
Before -after methods in crash analysis, Advanced statistical methods, Black Spot Identification & Investigations – spot map method, accident frequency method, accident rate method, GIS application in black spot studies.
Cause of accident **15 Hours**

Unit III
Road Safety Audits
Key elements of a road safety audit, Road Safety Audits & Investigations, Crash investigation and analysis, methods for identifying hazardous road locations.
Case Studies **15 Hours**

Unit IV
Mitigation Measures
Accident prevention by better planning, Accident prevention by better design of roads, Crash Countermeasures, Highway operation and accident control measures, Highway Safety Measures during construction, Highway geometry.
Geometry safety **15 Hours**

Total: 60 Hours

Textbook(s)

1. Ezra Hauer, Observational Before-After Studies in Road Safety, Pergamon Press, 1997 (reprinted 2002).
2. Institute of Transportation Engineers (ITE), The Traffic Safety Toolbox: A Primer on Traffic Safety, ITE, 1999.
3. Leonard Evans, Traffic Safety, Science Serving Society, 2004.
4. Lynn B. Fricke, Traffic Accident Reconstruction, Northwestern University Center for Public Safety, 1990.

Reference(s)

1. Ogden, K.W. Safer Roads: A Guide to Road Safety Engineering. Avebury Technical, 1996.
2. Popkess C.A, Traffic Control and Road Accident Prevention, Chapman and Hall, 1997
3. Rune Elvik and Truls Vaa, The Handbook of Road Safety Measures, Elsevier, 2004.
4. Simon Washington, Matthew Karlaftis, and Fred Mannering, Statistical and Econometric Methods for Transportation Data Analysis, Chapman & Hall/CRC Press, 2003.
5. Towards Safe Roads in Developing country, TRL – ODA, 2004

21TRE003 Rural Roads Planning and Design

4 0 0 4

Course Outcomes

1. Identify the important factors to be considered in planning the rural road network.
2. To design an optimum rural road network.
3. Identify the pavement materials to be used in rural construction
4. Design both flexible and rigid pavements for rural roads
5. To identify the critical quality aspects in the construction of rural roads
6. Build knowledge on maintenance and rehabilitation strategies for rural roads

Unit I

Planning of rural roads

Introduction to planning of low volume roads, concepts of network planning, selection of roadway alignment, factors affecting rout selection, engineering surveys for new road location.

Factor affecting alignment **15 Hours**

Unit II

Pavement Materials and Design of Rural Roads

Road materials for pavement construction, soil-subgrade, road aggregate, binder, test on soil, test on aggregates and test on bitumen, bituminous mix design, sustainable materials in rural road construction, factors affecting pavement design, function of different pavement components, design of flexible pavement and rigid pavement by using IRC method.

Sustainable pavement construction materials **15 Hours**

Unit III

Pavement Construction Specifications for Rural Roads

Road construction: Specifications of material and construction of sub grade, subbase, base and surface layer, construction of non-bituminous road, construction of bituminous roads, equipment required for construction, maintenance of low volume roads.

Advanced construction techniques for rural roads **15 Hours**

Unit IV

Maintenance and Rehabilitation of Rural Roads

Importance of maintenance, types of maintenance activities for rural roads, maintenance management principles, planning and economics of maintenance activities, timing of intervention, works preparation and planning.

Implementation arrangements **15 Hours**

Total: 60 Hours

Textbook(s)

1. A. Veeraragavan, S.K Khanna and C.E.G. Justo, Highway Engineering, Nem Chand & Brothers, 2014.
2. Yan H. Huang, Pavement Analysis and design, Second Edition, prentice hall inc, 2004

Reference(s)

1. Ethiopian Roads Authority, Design Manual for Low Volume Roads, Parts A-G: https://assets.publishing.service.gov.uk/media/57a08ad340f0b649740007ca/Design-Manual-for-Low-Volume-Roads-Part-G.pdf
2. IRC SP 20: Rural road manual, Indian road congress, New Delhi, 2002.
3. IRC SP 63: Guidelines for design and construction of cement concrete pavements for low volume roads, Indian road congress, New Delhi, 2014.
4. IRC SP 72: Guidelines for design of flexible pavements for low volume rural roads, Indian road congress, New Delhi, 2007.
5. IRC SP 126: Guidelines for the design and construction of low volume rural roads using jute geotextiles, Indian road congress, New Delhi, 2019.

21TRE004 Intelligent Transport Systems

4 0 0 4

Course Outcomes

1. Differentiate ITS user Services.
2. Apply ITS for road user safety.
3. Interpret importance of AHS in ITS.
4. Extend future research and special project.
5. Gain knowledge on ITS applications
6. Understand the role of sensors in ITS

Unit I

Fundamentals of ITS

Definition of ITS, the historical context of ITS from both public policy and market economic perspectives, Types of ITS; Historical Background, Benefits of ITS.

Dedicated short range communication, Intermodal Freight **15 Hours**

Unit II

Sensor Technologies and Data Requirements of ITS

Importance of telecommunications in the ITS. Information Management, Traffic Management Centers (TMC). Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centres; specification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts; ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), video data collection.

GIS, Sensor plan **15 Hours**

Unit III

ITS User Needs and Services

Functional areas – Introduction, Advanced Traffic Management systems (ATMS), Advanced Traveller Information systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control systems (AVCS), Advanced Public Transportation systems (APTS), Advanced Rural Transportation systems (ARTS).

Automated highway systems, electronic toll collection **15 Hours**

Unit IV

ITS Applications

Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.; Transportation network operations; commercial vehicle operations and intermodal freight; public transportation applications; ITS and regional strategic transportation planning, including regional architectures: ITS and changing transportation institutions - Vehicles in Platoons – Integration of Automated Highway Systems, ITS Programs in the World – Overview of ITS implementations in developed countries.

Advanced Traveller Information Systems, field trip to Smart Route Systems **15 Hours**

Total: 60 Hours

Textbook(s)

1. Ghosh, S., and Lee, T. S., Intelligent Transportation Systems: New Principles and Architectures, CRC Press, Washington D.C., 2000.
2. Chowdhury, M. A., and Sadek, A. W., Fundamentals of Intelligent Transportation Systems Planning, Artech House Inc., Norwood, MA, 2003.
3. Roess, R. P., Prassas, E. S., and McShane, W. R., Traffic Engineering, 4th Edition, Pearson Higher Education Inc., New Jersey, 2011.

Reference(s)

1. Sussman, J.M., Perspectives on Intelligent Transportation Systems, Springer, Berlin, 2010.
2. Perallos, A., hernndex-Jayo, U, Onieva, E., and Garcia-Zuazola, I., Intelligent Transport Systems: Technologies and Applications, John Wiley & Sons Ltd., West Sussex, United Kingdom, 2016.

21TRE005 Ground Improvement Techniques

4 0 0 4

Course Outcomes

1. Apply the principles of ground improvement to a given site condition.
2. Prioritize the right technique to improve different difficult grounds.
3. Ensure safe, stable and economical construction for any structure.
4. Propose the best suitable ground modification technique for different grounds.
5. Choose the best admixture for stabilization of ground for different grounds.
6. Build knowledge on importance and application of Gabion walls and crib walls.

Unit I

Introduction to Ground Modification

Need and objectives of Ground Improvement, Classification of Ground Modification Techniques-suitability and feasibility, Emerging Trends in ground improvement. Mechanical Modification; Principles and methods of soil compaction, Compaction control, Compaction piles, dynamic compaction, Vibrofloat technique, controlled blasting for compaction.

Soil compaction, Vibro-float technique **15 Hours**

Unit II

Physical, Chemical Modification and Grouting

Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen. Grouting: Categories of grouting, Grout materials, Grouting techniques and control.

Grouting, lime, fly ash, CaCl2 **15 Hours**

Unit III

Hydraulic Modification and Geo-textiles

Methods of dewatering open sumps and ditches, Well-point system, Electro-osmosis, Vacuum dewatering; Pre-loading without and with sand drains, strip drains and rope drains. Types of Geo-textiles, Woven and non-woven fabrics, Geo-membranes, Geo grids, Geo-composites, Geo-nets, Functions and applications, Properties of geo-textiles.

Dewatering, Geotextiles, Geogrids, Geomembranes, Geonets. **15 Hours**

Unit IV

Reinforced Earth and In-Situ Ground Treatment for Slopes

Concept of soil reinforcement, reinforcing materials, Backfill criteria, Design and construction of reinforced earth structures. Soil nailing, Rock anchoring, Micro-piles, design methods, construction techniques; Gabion walls, Crib walls.

Soil reinforcement-Soil Nailing-Rock anchoring-Micropiles-Gabion Walls-Crib wall. **15 Hours**

Total: 15 Hours

Text Book(s)

1. Hansmann, M. R., Engineering principles of ground modification, McGraw-Hill Publications, New York, 1990.
2. Purushothama Raj, P., Ground Improvement Techniques, Laxmi Publications (P) Limited, New Delhi, 2005.

Reference(s)

1. Koerner, R. M., Construction and Geotechnical methods in Foundation Engineering, McGraw-Hill Publications, New York, 1984.
2. Fang, H., Foundation Engineering Hand Book, 2nd Edition, Van Nostrand Reinhold Co., New York, 1991.

21TRE006 Construction Technology and Equipment

4 0 0 4

Course Outcomes

1. Develop an understanding of the fundamentals of the technology involved in the construction.
2. Gain knowledge on advantages and limitations of various equipment used in road construction
3. Explain the various equipment required for earthwork
4. Built knowledge on the production equipment of aggregates.
5. Built knowledge on the production equipment of concrete and HMA
6. Infer a basic understanding of the equipment involved in pavement construction.

Unit I

Importance of Plants and Equipment's

Introduction importance of plants and equipment's – advantages and limitations, types of construction equipment used in road construction.

Advantages and limitations, types of construction equipment used in road construction **15 Hours**

Unit II

Earthwork Equipment

Equipment for earthwork, hauling and spreading Dozers, excavators, loaders, hauling units, graders – application types, production, factors effecting the production.

Equipment for earthwork, excavators, loaders, hauling units, graders, application types **15 Hours**

Unit III

Mixer Plant

Plants for productions of aggregates and mixes crushers- types, factors effecting the production, Pug mill for production wet mix macadam, Hot bituminous mix plants – types, production process, Concrete batching plant- cement concrete production process.

Factors effecting the production, Pug mill for production wet mix macadam **15 Hours**

Unit IV

Paving Equipment

Paving and Compacting Equipment Pavers – components, types of pavers, factors influencing paving quality, Compactors – types, application, Miscellaneous equipment – Kerb casting equipment, road marking equipment, bitumen sprayers.

Paving and Compacting Equipment Pavers – components, types of pavers, factors influencing paving quality, Compactors – types, application **15 Hours**

Total: 60 Hours

Textbook(s)

1. Peurifoy, R.L., Schexnayder, J. C., Schmitt, R., and Shapira, A., "Construction Planning, Equipment, and Methods ", 9th Edition, McGraw-Hill Education, Singapore, 2018.
2. Hot-Mix Asphalt Paving Handbook 2000, Army Corps of Engineers, Federal Aviation Administration, Washington DC., United States, 2000.
3. Concrete Pavement Design and Construction Practices, State of the Art Technical Digest, prepared under FHWA Task Order DTFH61-98-T07007, Applied Pavement Technology, Inc, Urbana, 1999.

Reference(s)

1. Sharma S.C. "Construction Equipment and Management ", Khanna Publishers New Delhi.
2. Roberts, F. L., Kandhal, P. S., Brown, E. R., Lee, D. Y., and Kennedy, T. W., Hot Mix Asphalt Materials, Mixture Design, and Construction, 2nd Edition, National Asphalt Pavement Association Education Foundation, USA, 1996.
3. IRC:015-2011 Standard Specifications and Code of Practice for Construction of Concrete Roads, 4th Revision, Indian Roads Congress, New Delhi, India
4. IRC:043-2015 Recommended Practice for Plants, Tools, and Equipment required for Construction and Maintenance of Concrete Roads, 1st Revision, Indian Roads Congress, New Delhi, India
5. IRC:072-1978 Recommended practice for Use and Upkeep of Equipment, Tools and Appliances for Bituminous Pavement Construction, Indian Roads Congress, New Delhi, India

21TRE007 Airport, Railway and Harbor Engineering

4 0 0 4

Course Outcomes

1. Develop an understanding of overall Airport, Port and Harbour Engineering and its impact.
2. Build knowledge on the Key design Characteristics for design of Elements like Groins, Break waters
3. Perceive with advanced topics like Deck and Fenders, Dolphins etc.
4. Extend knowledge on flow regime, lift force mechanism, bed load and suspended load etc.
5. Assess the design principles and construction of jetties.
6. Build knowledge on design of offshore structures.

Unit I

Airport Planning and Design

Airport site selection, Airport Classification-Runway orientation–Wind rose diagram Runway length – Taxiway design–Terminal area and Airport layout -Visual aids and Air traffic control.

Hanger, Runway marking **15 Hours**

Unit II

Introduction to Railway Engineering

Permanent way components -Cross Section of Permanent Way - Functions of various Components like Rails, Sleepers and Ballast -Rail Fastenings -Creep of Rails- Adzing of Sleepers- Sleeper density. Geometric Design of Railway Track: Gradients- Grade Compensation- Can't and Can't Deficiency -Degree of Curve - Crossings and Turn outs.

Negative Super elevation, Alternative ballast materials **15 Hours**

Unit III

Planning of Shore Structures

Definition of Terms - Harbors, Ports, Docks, Tides and Waves, Littoral Drift, Sounding, Locks and lock gates, Site Selection & Considerations- Proximity to Towns/Cities, Utilities, Construction Materials, Coast Lines, Ports-Requirements and Classification of Harbors. Light house, Dredging

Tides and Waves, Littoral Drift **15 Hours**

Unit IV

Construction and Maintenance of Docks & Harbours

Coastal Structures- Piers, Breakwaters, Wharves, Quays, Fenders, Inland Water Transport and Container Transportation. Pipe Ways, Rope Ways, Maintenance of Ports and Harbors – Navigational aids. Jetties, Dolphins

Inland Water Transport and Container Transportation **15 Hours**

Total: 60 Hours

Text Book(s)

1. Khanna, S. K., Arora, M. G., and Jain, S. S., Airport Planning and Design, 6th Edition, Nem Chand Bros Publishers, New Delhi, 1999.
2. Bindra, S. P., A course on Docks and Harbour Engineering, Dhanpat Rai & Sons Publishers, New Delhi, 1992.
3. Arora, S. P., and Saxena, S. C., A Text Book of Railway Engineering, Dhanpat Rai & Sons Publishers, New Delhi, 2005.

Reference(s)

1. Ashford, N. J., Mumayiz, S. A., and Wright, P. H. Airport Engineering: Planning, Design and Development of 21st Century Airports, 4th Edition, John Wiley & Sons, New Jersey, USA, 2011.
2. Oza, H. P., and Oza, G. H., Dock and Harbor Engineering, Charotar Publishing House Pvt. Ltd., New Delhi, 1999.
3. Chandra, S., and Agarwal, M. M., Railway Engineering, Oxford University Press India, New Delhi, 2013.
4. Kumar, V., and Chandra, S., Air Transportation Planning and Design, Galgotia Publications Pvt Ltd., New Delhi, 1999.

21TRE008 RS and GIS for Transportation Engineering

4 0 0 4

Course Outcomes

1. Interpret various remotely sensed images with the help of acquired knowledge in remote sensing technology.
2. Apply the GPS instrument in field for various applications
3. Make use of the techniques of RS, GIS and GPS techniques in different transportation engineering applications.
4. Build knowledge on Global positioning system.
5. Compare between Raster GIS and vector GIS.
6. Extend knowledge on Intelligent Transportation systems

Unit I

Introduction to Remote Sensing and Remote Sensing

Platforms & Sensors, Basic concepts and foundation of remote sensing, Elements involved in remote sensing, Electromagnetic spectrum, remote sensing terminology and units, Energy resources, energy interactions with earth surface features and atmosphere and spectral properties of vegetation, soil and water bodies, Concept of resolution in Remote Sensing. Remote Sensing Platforms & Sensors: Introduction, Characteristics of imaging remote sensing instruments, satellite remote sensing system-a brief over view, other remote sensing satellites. Elements of Visual Interpretation and techniques digital data analysis.

Satellite remote sensing system-a brief over view, Elements involved in remote sensing, Electromagnetic spectrum, remote sensing terminology and units **15 Hours**

Unit II

Geographic Information System and Types of data representation

Introduction, GIS definition and terminology, GIS categories, components of GIS, fundamental operations of GIS, A theoretical framework for GIS. Types of data representation: Data collection, data input and output. Keyboard entry and coordinate geometry procedure, manual digitizing and scanning, Raster GIS, Vector GIS–File management, Spatial data–Layer based GIS, Feature based GIS mapping.

GIS categories, components of GIS, Spatial data–Layer based GIS, Raster GIS **15 Hours**

Unit III

GIS Spatial Analysis and Global Positioning System

Computational Analysis Methods (CAM), Visual Analysis Methods (VAM), Data storage-vector data storage, attribute data storage, overview of the data manipulation and analysis. Integrated analysis of the spatial and attribute data. Global Positioning System: Introduction, elements of satellite surveying, the global positioning system, GPS satellites, adjustment computations.

Analysis Methods (VAM), Data storage-vector data storage, attribute data storage **15 Hours**

Unit IV

Integration of RS and GIS for Transportation Engineering

Transportation Engineering Applications Intelligent Transportation Systems (ITS) for road accessibility study, GIS data base design for physical facility planning, Decision support systems for land use planning. GIS based Highway alignment, GIS based road network planning, GIS based traffic congestion analysis and accident investigation. Network planning. GIS-T Applications and some case studies.

Intelligent Transportation Systems (ITS), GIS based Highway alignment, Network planning, GIS-T Applications and some case studies. **15 Hours**

Total: 60 Hours

Textbook(s)

1. Cambell, J. B., Wynne, R. H., and Thomas, V. A., Introduction to Remote Sensing, 6th Edition, Guilford Publications, New York, 2022.
2. Longley, P. A., Goodchild, M. F., Maguire, D. J., and Rhind, D. W., Geographical Information System, Volume I: Principal and Technical Issues, 2nd Edition, John Wiley & Sons, USA, 1999.

3. Longley, P. A., Geographical Information System: Volume II: Management Issues and Applications, John Wiley & Sons, USA, 1999.
4. Leick, A., Rapoport, L., and Tatarnikov, D., GPS Satellite Surveys, Willey & Sons, USA, 2015.

Reference(s)

1. Lillesand, T., Kiefer, R. W., Chipman, J., Remote Sensing and Image Interpretation, 5th Edition, Wiley India Pvt Ltd., USA, 2015.
2. Sabins, F. F., and Ellis, J., Remote Sensing: Principles and Interpretation, 3rd Edition, Waveland Press, USA, 2020.
3. Chandra, A. M., and Ghosh, S. K., Remote Sensing and Geographical Information System, Alpha Science International Ltd., New Delhi, 2015.
4. Reddy, M. A., Textbook of Remote Sensing and Geographical Information, B.S. Publications, Hyderabad, 2013.

21TRE009 Road Projects

4 0 0 4

Course outcomes

1. Prepare project report for new and up-gradation type road works by conducting necessary feasibility/detailed studies.
2. Conduct the soil and material investigations to understand their behaviour and performance.
3. Perform various traffic related studies helping to finalize the project preparations and methods of forecasting traffic data.
4. Analyse the environmental impact of road projects and suggest suitable mitigation measures
5. Analyse the social impact of road projects and also determine the economic feasibility analysis for justification of investments.
6. Prepare DPR on road projects with relevant drawings and get the knowledge of tendering process for the construction.

Unit I

Road Project Reports

Salient features of on-going road projects in India, Objects and Scope of Prefeasibility, feasibility and detailed project report for road projects, typical HR structure for preparation of project reports and implementation of road projects, key acts related road projects.

Salient features of on-going road projects in India, typical HR structure for preparation of project reports and implementation of road projects **15 Hours**

Unit II

Surveys and Investigations for Road Improvement Projects

Traffic surveys and forecasting, topographical surveys, geotechnical and material surveys, Pavement surveys and investigations, Cross drainage structure and drainage surveys, Interpretation of survey results.

Geotechnical and material surveys, Pavement surveys and investigations **15 Hours**

Unit III

Environmental Impact Assessment

Objectives, procedure of environmental impact assessment, socio economic survey, mitigation measures, and Landscaping and tree plantation, implementation of environment management plan, Key environmental legislations, and clearances required for road project- environmental, forest, CRZ, wild life, air, noise quality standards

Socio economic survey, Environmental, forest, CRZ, wild life, air, noise quality standards **15 Hours**

Unit IV

Tender Evaluation and Roadway Facilities

Pedestrian facilities, bus bays, truck lay byes, traffic, medical and vehicle rescue aid posts, street lighting, Road safety audit, road safety furniture Preparation of BOQ, Types of tender documents, salient clauses of tender document, tender evaluation –technical and financial.

Medical and vehicle rescue aid posts, Road safety audit, Tender evaluation **15 Hours**

Total: 60 Hours

Textbook(s)

1. IRC: SP:19-2001 Manual for Survey, investigation and Preparation of Road Project, Indian Roads Congress, New Delhi, 2001.
2. IRC:73-1990 Guidelines for Geometric Design Standards of Rural Highways, Indian Roads Congress, New Delhi, 1990.
3. IRC:86-2018 Guidelines for Geometric Design standards of Urban roads, Indian Roads Congress, New Delhi, 2018.

Reference(s)

1. MoRTH Model Concession Agreement for Small Road Projects-2000, Indian Road Congress, New Delhi
2. Relevant IRC Guidelines

21TRE010 Urban Transportation Planning

4 0 0 4

Course Outcomes

1. Build knowledge on Factors underlying traveller choices of mode of travel and route choice
2. Extend knowledge on travel Forecasting models.
3. Develop Knowledge of data required for transportation planning.
4. Interpret the ability to make trade-offs with multiple factors in project planning and design.
5. List out the Steps those are necessary to complete a long-range transportation plan.
6. How engineers and planners interact with local and regional governments, citizens and elected officials to develop and interpret transportation plans

Unit I

Introduction and Urban Transportation System Planning

Conceptual Aspects Transport and Socioeconomic Activities, Historical Development of Transport, Transportation in the Cities, Freight Transportation, Future Developments. Transport Planning Process, Problem Definition, Solution Generation, Solution Analysis, Evaluation and Choice, Implementation.

Socio Economic environment-freight transport-transportation modes-Problem definition-value function-vehicle ownership-employment-land use. **15 Hours**

Unit II

Trip Generation Analysis and Mode Choice Modelling

Four step Travel Demand forecasting approach, Trip Production Analysis, Zonal models, Category Analysis, Trip Attraction Modelling: Influencing Factors, Earlier Modal Split Models, Trip-End Type Modal Split Model, Trip-Interchange Modal Split Model, Disaggregate Mode-Choice Model, Logit Model of Mode Choice, Binary Choice Situations, Multinomial Logit Model, Model calibration, Case studies.

Travel demand-trip production-trip attraction-regression analysis-category analysis-trip end-trip interchange-disaggregate. **15 Hours**

Unit III

Trip Distribution Models

PA Matrix, OD Matrix, Basis of Trip Distribution, Gravity Model, Calibration of Gravity Model, Singly and Doubly Constrained Gravity Models. Growth Factor Methods of Trip Distribution, Uniform Factor Method, Average Factor Method, Fratar Growth-Factor Method, and Disadvantage of Growth Factor Method.

OD matrix-gravity model-growth factor-fratar growth factor-average growth factor-singly constrained-fully constrained models **15 Hours**

Unit IV

Route Assignment and Transportation Surveys

Description of transport network, Route Choice Behaviour, The Minimum Path, Minimum Path Algorithm, Route Assignment Techniques, All-or-Nothing Assignment, Multipath Traffic Assignment, Capacity-Restrained Traffic Assignment. Definition of Study Area, Zoning, Types of Movements, Types of Surveys, Home-Interview Survey, Commercial Vehicle Survey, Intermediate Public Transport Survey, Public Transport Survey, Roadside-Interview Survey, Cordon-Line Survey, Post-Card Questionnaire Survey, Registration-Number Survey, Tag-on-Vehicle Survey.

Route choice behaviour-all-or-nothing-minimum path algorithm-capacity restrained traffic assignment-study area- traffic surveys. **15 Hours**

Total: 60 Hours

Textbook(s)

1. Kanafani, A., Transportation Demand Analysis, 1st Edition, McGraw Hill Publishers, New York, 1983.
2. Dickey, J. Metropolitan Transportation Planning, 2nd Edition, Tata Mc. Graw Hill Publishers, New Delhi, 1986.
3. De Dios Ortuzar, J., and Wilumsen, L. G., Modelling Transport, 2nd Edition, John Wiley Publications, 2011.

Reference(s)

1. Dr. V. Thamizh Arasan, NPTEL-Video lectures for “Urban Transportation Planning”, 2012.
2. Dr. Tom V. Mathew, NPTEL-Material for “Transportation Engineering I”, 2010.

21TRE011Transportation Systems Design

4 0 0 4

Course Outcomes

1. To identify requirements to design various elements of highway.
2. Design the longitudinal and cross-sectional elements of a highway
3. Build knowledge on design of intersection elements
4. Design of merging and diverging lanes, weaving sections
5. Design the interchanges, and parking facilities.
6. Design the facilities for bicyclists and pedestrians.

Unit I

Geometric Design of Highways

Design controls and criteria; Design Elements; Cross section Elements; Geometric standards for Mobility and Accessibility; Landscaping; Optical Design; Express ways Requirements – Weaving areas, Deceleration and Acceleration Lanes.

Ramp configurations **15 Hours**

Unit II

Geometric Design of At-grade Intersections

Types and their Suitability, Factors Affecting Design – Design Principles – Data Requirements, Parameters of Intersection Design, Principles of Channelisation, Functional Classification of Channelising Islands, Island Designs, Delineation and Approach-end Treatment, Design of Orthogonal, Skewed, Rotary Intersections, Mini Roundabouts and New Types of Intersections, Location of Bus Stops and Parking Controls.

Use of Templates and Flexi Curves **15 Hours**

Unit III

Geometric Design of Grade Separated Intersections

Types of grade separations; warrants; Spacing; Ramps; Control of Access; Design of Merging and Diverging lanes; Design of weaving sections, Over and Under structures; Vertical clearances;

Multiple interchange. **15 Hours**

Unit IV

Design of Bicycle and Pedestrian Facilities

Bikeways Facilities – Bikeway Design Specifications – Bikeway Level of Service – Junction Treatments – Bicycle Parking Facilities – Cycle Network Planning – Pedestrian Facilities – Pedestrian q-k-v Relationships – Walkway Widths – LOS for Walkways – Subways and Over Bridges – Pedestrian Precincts

Passenger Conveyors **15 Hours**

Total: 60 Hours

Textbook(s)

1. L.R. Kadiyali, Traffic Engineering and Transportation Planning, Khanna Publishers, 2011. 2. Chakroborty Partha, Das Animesh, Principles of Transportation Engineering, PHI Learning Pvt. Ltd., 1st Edition, 2009.
2. Roger P. Roess, Elena S. Prassas and William R. McShane, Traffic Engineering, Prentice Hall, 4th Edition, 2010. 4. May, A.D. Traffic Flow Fundamentals, Prentice Hall, 1st Edition, 1989.

Reference(s)

1. Fred L. Mannering, Scott S. Washburn, Kilareski Walter P., Principles of Highway Engineering And Traffic Analysis, Wiley India Pvt Ltd., 4th Edition, 2011.
2. Mike Slinn, Paul Matthews, Peter Guest, Traffic Engineering Design: Principles and Practice, Butterworth-heinemann, 2nd Edition, 2005.
3. Institute of Transportation Engineers, Traffic Engineering Hand Book; 4th Edition, Prentice Hall., 1991.
4. Salter R.J and N.B Hounsell, Highway Traffic Analysis and Design, 3rd Edition, Macmillan.

21TRE012 Smart Cities

4 0 0 4

Course Outcomes

1. Build knowledge on global standards and framework for smart cities.
2. Understand the governance, management and financing of smart cities.
3. Build knowledge on design of intersection elements
4. Interpret the key elements of transport planning in smart cities
5. Evaluate the role of non-motorized transport in smart city planning.
6. Build knowledge on planning the facilities for bicyclists and pedestrians in smart cities.

Unit I

Introduction to Smart city planning and development

Introduction and definition of smart city, Global standards and performance benchmarks, practice codes, smart city planning and development, Technological framework for smart cities, Project management in smart cities, Reconceptualization of smart cities and the challenges.

Financing and governance of smart cities **15 Hours**

Unit II

Transport Planning and Non-motorized Transportation

Planning Process; Measuring Current Nonmotorized Travel; Predicting Potential Nonmotorized Travel; Evaluating Existing Conditions and Prioritize Improvements. Surveys, Demand Estimation and Analysis; Crash Data, Barrier Effect; Cycling Condition Evaluation Techniques; Pedestrian Condition Evaluation Techniques.

Prioritizing improvements and selecting preferred options **15 Hours**

Unit III

Planning for Pedestrians and Bicyclists

Types of pedestrians and Characteristics; Pedestrian facilities and planning; Pedestrian standards and improvements; Pedestrian facility Design, LOS; Pedestrian safety programs, Types of cyclists and Bikeways; Integrating cycling into roadway planning; Bicycle network planning; Accommodating cyclists on rural roads; Design of Bicycle boulevards/bike paths; Bicycle Parking/storage Facilities;

Roadway maintenance for cyclists **15 Hours**

Unit IV

Strategies, Operations and Maintenance Programs

Comprehensive plans; Road design, reconstruction and maintenance requirements; Major projects and site plan agreements; Land Use Connectivity, Urban Design exchange, Rural areas, utility corridors, Safety education; Traffic law enforcement. Operations and Maintenance Resources/Costs; Signs and Pavement Markings; Routine and Remedial Operations;

Routine maintenance **15 Hours**

Total: 60 Hours

Text Book (S)

1. ADB, Guidelines for Non-Motorized Transport Measures: Policy and Options, Asian Development Bank, 2008. http://sti-india-uttoolkit.adb.org/mod5/se2/002.html
2. Fruin, Pedestrian Planning and Design, McGraw Hill Publication, 1987.
3. Hudson .M, The Bicycle Planning, Open Books, 1982.

Reference(s)

1. IRC codes for Design and Layout of Cycle Tracks and Pedestrian Facilities.
2. John Forester, Bicycle Transportation: A Handbook for Cycling Transportation Engineers, MIT Press, 1994.
3. Myer Kutz, Editor, Handbook of Transportation Engineering, McGraw-Hill Publishers, 2004.

21TRE013 Special Problems in Road Construction

4 0 0 4

Course Outcomes

1. Explain the difficulties of road construction in weak and marshy soils and the precautions to be taken.
2. Choose improvement methods of strengthening soil fills and embankments for pavement layers
3. Analyse the difficulties associated with construction of high embankments and maintaining hill slopes stability.
4. Analyse stresses in embankments
5. Evaluate the use of recycled materials in road construction with appropriate design methods, construction methods for roads in coastal and desert environment.
6. Built knowledge on the special construction techniques adopted for pavements

Unit I

Construction of roads in problematic soils and waterlogged areas

Various effective measures for solving the problems, machinery required and method of construction. Control of water table, capillary cut off and seepage flow in road construction. Design and construction of filter drains.

Capillary cut off and seepage flow in road construction, Control of water table **15 Hours**

Unit II

Methods of strengthening weak foundation soil

Acceleration of consolidation, settlement of compressible embankment, foundation using vertical sand drains-application, design and construction method.

Stabilization, waste utilization **15 Hours**

Unit III

Problems in construction of high embankments

Settlement and stability of embankment, foundation. Stability of hill slopes, control of erosion. Types of Failure of slopes, Methods of analysis of slope stability – Slip Circle and Taylors methods, Total and Effective Stress Methods, Determination of Stresses in Foundation for settlement Analysis, Analysis of Consolidation settlements of Embankments.

Stability of hill slopes, control of erosion, Types of Failure of slopes **15 Hours**

Unit IV

Special Road Construction Techniques

Construction techniques of cell filled concrete pavements–design, economics and construction method, and its application. Road construction on desert region and coastal areas, alternative methods, road construction on high altitudes, hilly and mountainous terrain. geo-synthetics for drainage and in pavement layers. Use of reinforced earth retaining walls, Nailing Technique, Techniques of pavement construction using recycled materials–cold and hot mix recycling of bituminous materials.

Road construction on desert region and coastal areas, geo-synthetics for drainage and in pavement layers

15 Hours

Total: 60 Hours

Textbook(s)

1. Koerner, R. M., Designing with Geosynthetics, 5th Edition, Prentice Hall, New Jersey, 2005.
2. Kassiff, G., Livneh, M., and wisemen, G. Pavements on Expansive clays, Jerusalem Academy Press, Jerusalem. Israel, 1969.

Reference(s)

1. Leonards, G. A., Foundation Engineering, McGraw-Hill Book Company, New York, ISBN-10: 0070371989; ISBN-13: 978-0070371989, 1962.
2. Cedgreen, H. R., Drainage of Highway and Airfield Pavements, John Willey & Sons. Inc, New York, ISBN: 1560512636, 1974.
3. Varghese, P. C., Foundation Engineering, PHI Learning, New Delhi, 2005.

21TRE014 Land Use and Transport Modelling

4 0 0 4

Course Outcomes

1. Understand the fundamentals of land use theory.
2. Apply land use theories for urban region development.
3. Apply evolving techniques to provide an interactive environment for transport development.
4. Develop travel demand models.
5. Understand the concept of regional network planning
6. Application of contemporary techniques for transportation modelling

Unit I

Land Use and Transportation Engineering

Transportation modelling in Planning; Models and their role, Characteristics of Transport demand and supply, Equilibrium of supply and demand, Modelling and decision making, Issues in Transportation modelling and structure of the classic transport model.

Characteristics of Transport demand and supply Modelling and decision making, Issues in Transportation modelling **15 Hours**

Unit II

Land Use Transportation and Activity Models

Introduction to Land Use Planning; Relation between Transportation and Land Use Planning; The economic base mechanism and allocation mechanism; Spatial allocation and employment interrelationship; Garin Lowry models.;

Activity modelling Relation between Transportation and Land Use **15 Hours**

Unit III

General Travel Demand Models and Regional Transport Models

Aggregate, Disaggregate models; Behavioural models; Recursive and direct demand Models; Linear, Non-Linear models; Logit, discriminant and Probit models; Mode split models - Abstract mode and mode specific models. Regional Transport Models: Factors affecting goods and passenger traffic; Prediction of traffic; Growth factor models; Time function iteration models;

Internal volume forecasting models. Factors affecting goods and passenger traffic, Mode split models

15 Hours

Unit IV

Regional Network Planning

Problems in Developing Countries, Network Characteristics - Circuitry, Connectivity, Mobility, Accessibility and Level of Service Concepts - Network Structures and Indices – Network Planning – Evaluation - Graph Theory – Cut sets – Flows & Traversing – Optimum Network - Inter-modal Co-ordination. – Rural Road Network Planning.; User equilibrium concepts- Advanced Spatial analysis Modelling: Applications of Artificial Neural networks, Cellular automata, Fuzzy logic systems, Genetic algorithms, artificial intelligence concepts to transportation Modelling.

Level of Service Concepts, Applications of Artificial Neural networks, User equilibrium **15 Hours**

Total: 60 Hours

Textbook(s)

1. Gibbs, J. P., and Davis, K., Urban Research Methods, Literary Licensing, New Delhi, 2012.
2. Whittick, A., Encyclopedia of Urban Planning, McGraw-Hill, New York, 1974.
3. Chari, S. R., Land-use Transportation Planning, Lecture Notes, National Institute of Technology (Regional Engineering College) Warangal, India 1978.

Reference(s)

1. Gibson, J. E., Designing the New City–A Systems Approach, John Wiley Sons, USA, 1977.
2. Barra, T., Integrated Land use and Transportation Modelling: Decision chains and Hierarchies, Cambridge University Press, UK, 1989.
3. Baxter, R. S., Echenique, M., and Owers, J., Urban Development Models, Construction press, 1975.

21TRE015 Pavement Management Systems

4 0 0 4

Course Outcomes

1. Extend Knowledge on fundamental issues in pavement management system.
2. Illustrate structural and functional evaluation of pavements.
3. Distinguish distress and surveys done on the pavement.
4. Dissect design strategies and economic evaluation.
5. Make use of expert systems in pavement management systems.
6. Build knowledge on project appraisal and its elements.

Unit I

Pavement Management Components Levels and functions

Pavement Management Components Levels and functions Definition-Components of Pavement Management Systems, Essential features. Ideal PMS Network and Project levels of PMS-Influence Levels-PMS Functions-Function of Pavement evaluation.

Network level, Project level, ideal PMS **15 Hours**

Unit II

Pavement Performance and Evaluation of Pavement Structural capacity

Pavement Performance and Evaluation of Pavement Structural capacity: Serviceability Concepts-roughness-Roughness Components-Equipment-IRI modelling techniques, structural condition deterioration models, mechanistic and empirical models, HDM and other models, comparison of different deterioration models Basics-NDT and Analysis-Condition Surveys-Distress-Destructive Structural Analysis Application in Network and Project Levels.

IRI, HDM, NDT, Distress, Serviceability **15 Hours**

Unit III

Pavement Design Selection and Alternatives

Pavement Design Selection and Alternatives: Design objectives and constraints, basic structural response models, physical design inputs, Alternate pavement design strategies and economic evaluation, life cycle costing, analysis of alternate pavement strategies based on distress and performance, case studies.

LCCA, alternate pavement strategies, Economic evaluation **15 Hours**

Unit IV

Expert Systems and Pavement Management, Project Appraisal

Expert Systems and Pavement Management, Project Appraisal: Role of computers in pavement management, applications of expert systems for managing pavements, expert system for pavement evaluation and rehabilitation, knowledge-based expert systems, case studies. Project appraisal: private sector participation Environmental impact assessment-TQM in highway projects.

Total quality management, project appraisal, EIA **15 Hours**

Total: 60 Hours

Textbook(s)

1. Haas, R., and Hudson, W. R., Pavement Asset Management, 1st Edition, McGraw-Hill Publishers, New York, 2015.
2. Haas, R., Hudson, W. R., and Zaniewski, J. P., Modern pavement Management, Krieger Publishing Company, Florida, US, 1994.

Reference(s)

1. Khanna, S.K., and Justo, C.E.G., Highway Engineering, 9th Edition, Nem Chand and Bros. Roorkee, 2011.
2. IRC:130-2020 Guidelines for Road Asset Management System, Indian Roads Congress, New Delhi, 2020.
3. IRC:115-2014 Guidelines for Structural Evaluation and Strengthening of Flexible Road Pavements Using Falling Weight Deflectometer (FWD) Technique, Indian Roads Congress, New Delhi, 2014.
4. IRC:117-2014 Guidelines for the Structural Evaluation of Rigid Pavement by Falling Weight Deflectometer, Indian Roads Congress, New Delhi, 2014.

21TRE016 Sustainable Highway Practices

4 0 0 4

Course Outcomes

1. Evaluate the suitability of special concretes for pavement applications
2. Built knowledge on advanced concrete pavements
3. Understand the advance bitumen practices in the civil engineering
4. Built knowledge on various modifiers used for bitumen
5. Characterize the properties of modified bitumen
6. Built knowledge on advanced bituminous pavements

Unit I

Special Concretes

Self-Compacting concrete, Polymer concrete, Fiber reinforced concrete, Reactive powder concrete-Bacterial concrete, Geo-polymer concrete, Requirements and guidelines, Advantages and Applications. Nano technology in cement concrete mix. IS method of cement concrete mix design.

Polymer concrete, Fiber reinforced concrete, Reactive powder concrete, Bacterial concrete **15 Hours**

Unit II

Advanced Concrete Pavements

Roller Compacted Concrete, Pervious cement concrete pavements, White Topping and its types. Precast concrete pavements, Cell-filled concrete pavements, Vacuum dewatering concrete pavements, interlocking block concrete pavements, and applications.

Vacuum dewatering concrete pavements, interlocking block concrete pavement **15 Hours**

Unit III

Modified Bitumen

Crumb Rubber Modified bitumen, Natural rubber modified bitumen, Polymer modified bitumen; Plastic modified bitumen. Introduction to emulsified bitumen and its characterization; Long term and short-term ageing and its effect on bitumen performance.

Crumb Rubber Modified bitumen, Natural rubber modified bitumen, Polymer modified bitumen

15 Hours

Unit IV

Advanced Bituminous Pavements

Mastic asphalt pavements, Pervious asphalt pavements, Perceptual pavements, Cold mix and warm mix asphalt pavements, guidelines, advantages and applications.

Mastic asphalt pavements, Pervious asphalt pavements, Perceptual pavements **15 Hours**

Total: 60 Hours

Text book(s)

1. Shetty, M. S., Concrete Technology: Theory and Practice, S. Chand Publishers, New Delhi, 2008.
2. Muench, S. T., Migliaccio, G. C., Kaminsky, J. A., Ashtiani, M. Z., Mukherjee, A., Bhat, C. G., and Anderson, J. L., Sustainable Highway Construction Guidebook, Transportation Research Board, USA, 2019.
3. The Asphalt Handbook, Asphalt Institute, United Kingdom 1988.

Reference(s)

1. Reid, J. M., Sustainable Highways: A Short Guide, Stationery Office, Department of Transport, Great Britain, United Kingdom, 2008.
2. Zhang, H., Asphalt and Asphalt Mixtures, IntechOpen Ltd., Croatia, United Kingdom, 2019.

21TRE017 Bridge Engineering

4 0 0 4

Course Outcomes

1. Develop an understanding of general considerations and specifications of road bridges from transportation Engineering point of view
2. Build knowledge on different types of loads induced on bridge
3. Extend knowledge on key design parameters for design of culverts
4. Analysis and design of deck slab and T – beam bridges
5. Design and check the stability of piers and abutments
6. Prioritize the best type of maintenance to be applied to various defects in bridges

Unit I

General Considerations and Standard Specifications for Road Bridges

Introduction –Site selection – Soil exploration for site – Selection of bridge type – Economical span – Number of spans –Determination of HFL – General arrangement drawing. Selection of bridge type – Economical span - Clearances - Loads to be considered - Dead load – I.R.C standard live loads -Impact effect - Review of I.R.C loadings - Application of live loads on deck slabs – Wind load – Longitudinal forces - Centrifugal forces - Horizontal forces due to water currents.

Selection of bridge type, Economical span, Application of live loads on deck slabs, Impact effect **15 Hours**

Unit II

Design of Culverts

Introduction analysis and design of – pipe culverts - slab culverts - box culverts -Reinforcement detailing need to be prepared.

Pipe culverts, slab culverts, box culverts **15 Hours**

Unit III

Design of Reinforced Concrete Bridges and Substructures

Introduction –Analysis and design of T – Beam girder bridges - Introduction to pier and abutments – Types of pier and abutments - Forces acting on Piers and Abutments - Analysis and Design of Abutments and pier – Types of Foundations.

Types of pier and abutments, Analysis and Design of Abutments and pier **15 Hours**

Unit IV

Construction and Maintenance of Bridges and Bridge Bearings

Construction method-short span bridges-Long span bridges-Formwork and false work for concrete bridges - Construction management-Numbering of Bridges Maintenance-Bridge failures - Bearings, forces on bearings, design of elastomeric bearings, basics for selection of bearings

Basics for selection of bearings, Formwork and false work for concrete bridges **15 Hours**

Total: 60 Hours

Text Book(s)

1. Victor, D. J., Essentials of Bridge Engineering, 6th Edition, Oxford & IBH Publishing Co., New Delhi, 2009.
2. Raju, N. K., Design of Bridges, 4th Edition, Oxford & IBH Publishing Co., New Delhi, 2010.

Reference(s)

1. Obrien, E. J., Keogh, D. L., and O'Connor, A. J., Bridge Deck Analysis, 2nd Edition, CRC Press, New York, 2015.
2. Jagadeesh, T. R., and Jairam, M. A., Design of Bridge Structures, Prentice Hall India Pvt, Ltd., New Delhi, 2021
3. Aswani, M. G., Vazirani, V. N., and Tatwani, M. M., Design of Concrete Bridges, Khanna Publishers, New Delhi, 1981.

21TRE018 Advanced Traffic Analysis

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Course Outcomes

1. Evaluate characteristics of traffic engineering like speed, flow and density
2. Analyze the intersections by understanding bottleneck and shock wave theory
3. Gain knowledge on various traffic stream models
4. Understand the concept of Queuing theory and its applications in traffic engineering
5. Design pedestrian facilities based on their behaviour and gap acceptance studies
6. Apply the concepts of simulation for solving real time traffic problems

Unit I

Traffic Flow Description

Traffic Stream Characteristics and Description Using Distributions: Measurement, Microscopic and Macroscopic Study of Traffic Stream Characteristics - Flow, Speed and Concentration; Use of Counting, Interval and Translated Distributions for Describing Vehicle Arrivals, Headways, Speeds, Gaps and Lags; Fitting of Distributions, Goodness of Fit Tests.

Headways, Speeds, Gaps and Lags **15 Hours**

Unit II

Traffic Stream Models

Fundamental Equation of Traffic Flow, Speed-Flow-Concentration Relationships, Normalized Relationship, Fluid Flow Analogy Approach, Shock Wave Theory - Flow Density diagram use in Shockwave analysis; Use of Time-space diagram for shockwave description; Bottleneck situations and shockwaves; traffic signal and shockwave theory; numerical Examples for application of shockwave theory; Car-Following Theory.

Speed-Flow-Concentration Relationships, traffic signal and shockwave theory **15 Hours**

Unit III

Queuing Analysis

Fundamentals of Queuing Theory, Demand Service Characteristics, Deterministic Queuing Models, Stochastic Queuing Models, Multiple Service Channels, Analysis of M/M/1 system; Assumptions and Derivation of System State Equations; Application of M/M/1 analysis for parking Garages and Toll Plazas-numerical Examples; Analysis of D/D/1 system for delay characteristics; Traffic Signal analysis as D/D/1 system; Computation of delays and queue dissipation Time – Numerical Examples.

Deterministic Queuing Models, Stochastic Queuing Models, Multiple Service Channels **15 Hours**

Unit IV

Pedestrian Delays and Gaps

Pedestrian Gap acceptance and delays; Concept of Blocks, Anti-blocks, Gaps and Non-Gaps; Underwood's analysis for Pedestrian Delays; Warrants for Pedestrian Crossing Facilities – Minimum Vehicular Volume Warrant, Minimum Pedestrian Volume Warrant, Maximum Pedestrian Volume Warrant; Simulation of Traffic: Introduction, Advantages of Simulation techniques, Steps in Simulation, Scanning techniques, Example of Simulation.

Pedestrian Gap acceptance and delays, Vehicular Volume Warrant, Minimum Pedestrian Volume Warrant, Maximum Pedestrian Volume Warrant **15 Hours**

Total: 60 Hours

Text book(s)

1. A policy on geometric design of highways and streets, American Association of State Highway Officials, USA, 2011.
2. IRC:86-2018 Geometric design standards for urban roads and Streets, 1st Revision, Indian Roads Congress, New Delhi, 2018.

Reference(s)

1. IRC:73-1990 Geometric design standards for rural (non-urban) highways, Indian Roads Congress, New Delhi, 1990.
2. Guidelines for expressways – Part I, Ministry of Road Transport & Highways, India, 2010.
3. Roadside design guide, American Association of State Highway Officials, USA, 2002.
4. Manual of geometric design standards for Canadian roads, Transportation Associations of Canada, 1986.

21AT0001RESEARCH METHODOLOGY and IPR

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Course Outcomes

1. Understand the various aspects of a research problem
2. Explain the importance of scope and objective of a research problem.
3. Analyze the various components of the format of a good research Proposal.
4. Identify the various concepts of IPR and patenting.
5. Interpret the various scopes of patent rights
6. Outline the various new developments in IPR

UNIT I
RESEARCH PROBLEM AND SCOPE FOR SOLUTION

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT II
FORMAT

Effective literature studies approaches, analysis, Plagiarism, Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT III
PROCESS AND DEVELOPMENT

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, patenting under PCT.

UNIT IV
PATENT RIGHTS and IPR

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Textbook (s)

1. Goddard, Wayne, and Stuart Melville. Research methodology: An introduction. Juta and Company Ltd, 2004.
2. Kumar, Ranjit. Research methodology: A step-by-step guide for beginners. Sage, 2018.

Reference (s)

1. Halbert, “Resist ing Intellectual Property”, Taylor & Francis Ltd ,2007.
2. Mayall, “Industrial Design”, McGraw Hill, 1992.
3. Niebel, “Product Design”, McGraw Hill, 1974.
4. Asimov, “Introduction to Design”, Prent ice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
6. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008