



GLA

UNIVERSITY

MATHURA

Established vide U.P. Act 21 of 2010.

COURSE CURRICULUM
DEPARTMENT OF CIVIL ENGINEERING

INSTITUTE OF ENGINEERING & TECHNOLOGY

COURSE STRUCTURE
M.TECH.
(TRANSPORTATION ENGINEERING)

First Semester

S. No.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACTS HRS/WK
			L	T	P		
1	MTEC0011	Advanced Traffic Engineering	4	0	0	4	4
2	MTEC0002	Pavement Analysis and Design	4	0	0	4	4
3	MTEC0003	Highway Soil Mechanics	4	0	0	4	4
4	MTEC0004	Numerical Methods and Applied Statistics	4	0	0	4	4
5	MTEC0005	Transportation Economics and Evaluation	4	0	0	4	4
6	MTEC0006	Advanced Railway Engineering	4	0	0	4	4
7	MTEC0800	Modelling, Analysis and Simulation Lab	0	0	2	1	2
		TOTAL	24	0	2	25	26

Second Semester

S. No.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACTS HRS/WK
			L	T	P		
1	MTEC0007	Urban Transportation Planning	4	0	0	4	4
2	MTEC0008	Construction Planning and Management	4	0	0	4	4
3	MTEC0009	Ground Improvement Techniques	4	0	0	4	4
4	MTEC0010	Introduction to Remote Sensing and GIS	4	0	0	4	4
5	MTEC0801	Application of Remote Sensing & GIS in Transportation Engineering	0	0	4	2	4
6		ELECTIVE - I	4	0	-	4	4
		TOTAL	20	-	4	22	24

Third Semester

S. No.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACTS HRS/WK
			L	T	P		
1	MTEC0802	Computer Aided Transportation Engineering Lab	0	0	4	2	4
2		ELECTIVE - II	4	0	0	4	4
3	MTEJ0971	Dissertation – I	-	-	-	4	-
4	MTEJ0961	Seminar	0	0	4	2	4
TOTAL			4	0	8	12	12

Fourth Semester

S. No.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACTS HRS/WK
			L	T	P		
1	MTEJ0972	Dissertation - II	-	-	-	14	-
TOTAL			-	-	-	14	-
Total Credits for all Semesters						73	

Elective - I

S. No.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACTS HRS/WK
			L	T	P		
1	MTEE0001	Highway Construction, Quality Control and Maintenance	4	0	0	4	4
2	MTEE0002	Intelligent Transportation System	4	0	0	4	4
3	MTEE0003	Airport Planning and Design	4	0	0	4	4
4	MTEE0004	Advanced Concrete Technology	4	0	0	4	4
5	MTEE0005	Finite Element Method	4	0	0	4	4

Elective - II

S. No.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACTS HRS/WK
			L	T	P		
1	MTEE0006	Design of Reinforced Concrete Bridges	4	0	0	4	4
2	MTEE0007	Soil Structure Interaction	4	0	0	4	4
3	MTEE0008	Road Materials and New Innovations in Pavement Engineering	4	0	0	4	4
4	MTEE0009	Highway Construction Practice	4	0	0	4	4

SEMESTER - I

MTEC0011 : ADVANCED TRAFFIC ENGINEERING

Credits: 04

Semester - I

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	Traffic Engineering & Studies: Scope, traffic elements, characteristics, vehicle, road user and road; traffic studies, volume, O & D, parking, safety, study methodology, data collection & presentation,	12
II	Traffic Analysis: Speed, volume, parking & accident data analysis, statistical approach, conflict points, traffic stream characteristics, relationship between speed, flow and density, LOS & capacity analysis, traffic forecasting.	14
III	Traffic Design: Channelisation of islands, design of rotaries, intersections, pedestrian & bicycle ways, Traffic Control Devices: Traffic signs, markings and signals; Traffic Regulation & Management: Speed, vehicle, parking, enforcement regulations, mixed traffic regulation, management various techniques Geometric design provisions for various transportation facilities as per AASHTO, IRC design.	14

Reference Books:

1. Pignataro L.J., *Traffic Engineering, Theory & Practice*, John Wiley publishing house
2. O'Flaherty, Edward Arnold, *Highways, Traffic Planning & Engineering*, UK
3. Kadiyali L.R., *Traffic Engineering and Transport Planning*, Khanna Publishers
4. Relevant IS and IRC codes

MTEC0002: PAVEMENT ANALYSIS AND DESIGN

Credits: 04

Semester - I

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	Pavements :History of Pavements, Pavements types, Advantages and Dis advantages Pavement Mix Analysis: Aggregate blending, bituminous mix design, Marshall Stability approach, concrete mix design for roads. Pavement Basics: Types & comparison, vehicular loading pattern, loading pattern on airport pavement, factors affecting design and performance of pavements, airport pavement, environmental impact on pavements, sub grade requirements	12
II	Design of Flexible Pavements: Analytical approach, flexible pavement layers, ESWL, repetitions of load, techniques of design methods, wheel load analysis, traffic analysis, stress distribution in subgrade soil, Burmister's theories, group index method, CBR approach, IRC guidelines, CRV method, triaxial & McLeod method, present practices, shoulder design.	14
III	Design of Concrete Pavements: Westergaard's approach, temperature & frictional stresses, design of expansion & longitudinal joints, design of dowel & tie bars, IRC guidelines, present design practices	14

Reference Books:

1. Yoder and Witezak, *Principles of Pavement Design*, John Wiley and sons
2. Yang, *Design of functional pavements*, McGraw,Hill
4. IRC codes : 37, 58, 15 and other relevant codes

MTEC0003 : HIGHWAY SOIL MECHANICS

Credits: 04

Semester - I

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	<p>Classification of Soil: HRB classification. Group Index Method.</p> <p>Subsoil drainage in Highway: Design of filters, perforated pipe drainage., Methods of sub soil drainage for roads, permeable blankets, longitudinal and transverse under drains, horizontal drains, stabilizing trenches. Sub soil drainage in runways and railways.</p>	12
II	<p>Compaction: Mechanics of compaction. Field compaction equipment; their suitability and choice. Compaction quality control and measurement.</p> <p>Shear Strength: Terzaghi's effective stress principle, effective shear parameters, measurement of pore pressures. Stability Analysis of slopes: Friction circle method, Taylor's Stability No.</p> <p>Earth Pressure Theories: Coloumb's Wedge Theory, Culman's method. Sheet pile walls and their analysis.</p>	14
III	<p>Deep foundations: Meyorhoff's theory for bearing Capacity. Well foundations, their types, components, well sinking and rectification. Stability analysis.</p> <p>Rock Engineering: Fundamental of rock Mechanics; Rock Properties; Rock Mass Classification Systems, Rock load classification according to Terzaghi, RQD index as a qualitative description of the rock mass, limitations and advantages, Geomechanics Classification: General Comments on Application of Rock Mass Classification Schemes, Comparison of Rock Mass Classification Schemes.</p>	14

Reference Books:

1. Rodriguez,A,R, Castillo del.h, *Soil Mechanics in Highway Engineering*, Trans Tech Publications
2. David McCarthy, *Essentials of Soil Mechanics and Foundations*, Pearson Education
3. R. Whitlow, *Basic Soil Mechanics*, Pearson Education

MTEC0004 : NUMERICAL METHODS AND APPLIED STATISTICS

Credits: 04

Semester - I

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	<p>Sampling Theory: Population Parameter, Sample Statistics, Sampling distributions, Sample mean, Sampling distribution of means, the sample variance, the sampling distribution of variance.</p> <p>Estimation Theory: Point estimate and interval estimates, reliability, confidence interval estimates of population parameters, confidence intervals for means, proportions and variance.</p>	12
II	<p>Tests of Hypothesis and Significance: Statistical decisions, tests of hypotheses and significance, Type I and Type II errors, level of significance, one tailed and two tailed tests. Tests involving small samples and large samples, fitting theoretical distributions to sample frequency distribution, The chi, square test for goodness of fit.</p>	14
III	<p>Linear Programming: Formulation of linear programming problem, Graphical solution, simplex method (including Big M method and two phase method), dual problem, duality theory, dual simplex method, revised simplex method.</p> <p>Transportation problem: existence of solution, degeneracy, MODI method; Assignment problem, traveling salesman problem</p> <p>Nonlinear programming problem (NLPP): Constrained NLPP, Lagrange's multipliers method, convex NLPP, Kuhn, Tucker conditions.</p>	14

Reference Books:

1. M.R. Spiegel, *Probability and Statistics*, McGraw Hill,
2. H.A. Taha, *Operation Research*, Prentice Hall of India Pvt. Ltd.
3. J.C. Pant, *Introduction to Optimisation : Operations Research*, Jain Brothers, New Delhi.
4. Miller and Freund, *Probability and Statistics for Engineers*.

MTEC0005 : TRANSPORTATION ECONOMICS AND EVALUATION

Credits: 04

Semester - I

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	Principles of Economics: Supply and demand models, consumer's surplus and social surplus criteria, framework for social accounting: accounting rate of interest, social opportunity cost, rate of interest, social time preference rate of interest, accounting prices of goods and services, measuring input costs, applications o social accounting frame work.	12
II	Transport Costs and Benefits: Fixed and variable cost, cost of improvement, maintenance cost, cost estimating methods, accounting for inflation, external costs, pavement cost analysis. direct benefits, reduced vehicle operation costs, value of travel time savings, value of increased comfort and convenience, cost of accident reduction, reduction in maintenance cost.	14
III	Economic Analysis: Generation and screening of project alternatives, different methods of economic analysis: annual cost and benefit ratio methods, discounted cash flow methods, shadow pricing techniques, determination of IRR and NPV, examples of economic analysis, application economic theory in traffic assignment problem.	14

Reference Books:

1. *Highway Economic Analysis*, Winfrey R, International Textbook Company
2. *Transport : An Economics and Management Perspective*, Oxford University Press

MTEC0006 : ADVANCED RAILWAY ENGINEERING

Credits: 04

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	Basics & Design Calculations in Indian Railways: Rail & rail joints (welding of rails, LWR, SWR, CWR), failures in rails, Sleepers, Ballast, Formation and its drainage, track fitting and fastening, Alignment and grades, cross section and its elements (at filling & cutting), grade compensation, cant and cant deficiency, negative cant and widening of gauges on curves, curves used for railway track (horizontal and vertical curves). Elements of A Simple Turn-Out, Details of Switch, Details of Crossings, Number and Angle of Crossings, Geometric Design of Turn-Out.	13
II	Railway Crossings: Various type of crossings and their specifications – ROB, Level Crossings, Rail Underpass, etc. Inspection & Monitoring of Railway Tracks: Track inspection vehicles, track geometry measurement systems, Ride quality measurements	13
III	Construction & Relaying Techniques: Telescopic, Trame Line, Mechanical methods of Construction	14

Reference Books / Text Book / Cases:

1. Arora, S.P. and Saxena, S.C. , *Railway Engineering*, New Delhi, Dhanpat Rai Publications, (2006).
2. Chandra, S. and Agarwal, M.M., *Railway Engineering*, New Delhi Oxford University Press, (2008).
3. Khanna, S.K., Arora, M.G., and Jain, S.S., "*Airport Planning and Design*", Roorkee, Nem Chand and Bros, (1994).

MTEC0800 : MODELLING, ANALYSIS AND SIMULATION LAB

Credits: 02

L-T-P: 0-0-2

Module No.	Contents	Teaching Hours
I	Computer graphics applications and automated drafting; Digitization; Usage of plotter, etc. Functional and geometric design of traffic facilities; Plan and layout of major at, grade and grade, separated interactions; Transportation Software: VISSIM, SIDRA	26

Reference Books/ Text Books :

1. VISSIM 5.30-05 User Manual
2. <https://communities.bentley.com/products/road.../video-replace-reference>
3. Khanna, S. K. and Justo C. E. G., Highway Engineering, Roorkee, Nemchand Bros. (2001).
4. Khisty C.J & Lall B. K., *Transportation Engineering*, Prentice Hall of India (2002).
5. Kadiyali, L. R., Traffic engineering and transport planning, 6th edition, Khanna publishers (2011).

SEMESTER - II

MTEC0007 : URBAN TRANSPORTATION PLANNING

Credits: 04

Semester - II

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	<p>Introduction: Transport and Socioeconomic Activities, Historical Development of Transport, Transportation in the Cities, Freight Transportation, Future Developments.</p> <p>Urban Transportation System Planning, Conceptual Aspects: Transport Planning Process, Problem Definition, Solution Generation, Solution Analysis, Evaluation and Choice, Implementation, Sequence of Activities Involved in Transport analysis.</p>	12
II	<p>Trip Generation Analysis: Trip Production Analysis, Category Analysis, Trip Attraction Modelling.</p> <p>Mode Choice 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.</p> <p>Trip Distribution Analysis: Presentation of Trip Distribution Data, PA Matrix to OD Matrix, Basis of Trip Distribution, Gravity Model of Trip Distribution, Calibration of Gravity Model, Singly and Doubly Constrained Gravity Models, A case Studies, Growth Factor Methods of Trip Distribution, Uniform Factor Method, Average Factor Method, Fratar Growth Factor Method, Disadvantage of Growth Factor Method.</p> <p>Route Assignment: Description of transport network, Route Choice Behavior, The Minimum Path, Minimum Path Algorithm, Route Assignment Techniques, All or Nothing Assignment, Multipath Traffic Assignment, Capacity Restrained Traffic Assignment</p>	14
III	<p>Transport Related Land Use Models: Development of Land, Use models, The Lowry Model, Application of Lowry Model.</p> <p>Urban Structure: Urban Activity Systems, Urban Movement Hierarchies, Types of Urban Structure, Centripetal, Type Urban Structure, Grid Type Urban Structure, Linear, Type Urban Structure, Directional Grid Urban Structure.</p> <p>Urban Goods Movement: Classification of Urban Goods Movements, Methodology of Approach to Analysis of Goods Movement, Modelling Demand for Urban Goods Transport.</p>	14

Reference Books:

1. C. S. Papacostas and P. D. Prevedouros, *Transportation Engineering and Planning*, Trans Tech Publications
2. Hutchinson, B.G. (1974). *Principles of Urban Transport Systems Planning*, Mc Graw Hill Book Company, New York.
3. Michael D. Meyer, Eric J. Miller, *Urban Transportation Planning*, McGraw, Hill
4. G. E. Gray and L. A. Hoel, *Public Transportation*, New Jersey, (1992)

MTEC0008 : CONSTRUCTION PLANNING AND MANAGEMENT

Credits: 04

Semester - II

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	Understanding Project Management, Project manager, Organization structures, Stages of Construction, organizing and staffing the project office and team	12
II	Construction Planning: Project planning, milestone schedules, WBS, Network techniques, CPM, PERT and Prima Vera, Line of Balancing Techniques, Critical Chain Method, Resources leveling and smoothing. Project Management Information system : MIS reporting, Daily, Weekly and monthly reporting, Actual vs. Planned reporting, Planning & Cost control document . Quality and safety documents at site.	14
III	Material management, purchases management and inventory control, ABC analysis. Management: Introduction for Management, History of Management theory, Leadership, Motivational Theories, Project controls. Construction Labor: Payment of wages Act, Workmen's Compensation Act, Minimum Wages Act.	14

Reference Books:

1. Harold Kerzner, *Project Management*, CBS Publisers & Distributors 2nd Edition.
2. Frank Harris & Ronald Mc CafferModern, *Construction Management*, Blackwell science4th Edition.
3. Roy Pilcher, *Principles of Construction Management*, Mc Graw Hill London.
4. Kumar Neeraj Jha, *Construction Project Management*, Pearson Publication.
5. Harvey Maylor, *Project Management*, 3rd Edition, Pearson
6. K.K. Chitkara, *Construction Project Management*, 2nd Edition, McGraw Hill Publication
7. P G. Gahoit & B.M. Dhir, *Construction Management*, New age international (p) Ltd.
8. N.D. Vora, *Quantitative Techniques in Management*, Tata McGraw Hill, New Delhi, 3rd Edition.
9. Daniel Halpin, *Construction Management*, 3rd Edition, John Wiley & Sons, Inc.

MTEC0009 : GROUND IMPROVEMENT TECHNIQUES

Credits: 04

Semester - II

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	<p>Introduction : Need for Ground Improvement, Different types of problematic soils, Emerging trends in ground Improvement.</p> <p>Mechanical stabilization : Shallow and deep compaction requirements, Principles and methods of soil compaction, Shallow compaction and methods. Properties of compacted soil and compaction control, Deep compaction and Vibratory methods Dynamic compaction.</p>	12
II	<p>Hydraulic modification: Ground Improvement by drainage, Dewatering methods. Design of dewatering systems, Preloading, Vertical drains, vacuum consolidation, Electro-kinetic dewatering, design and construction methods.</p> <p>Modification by admixtures : Cement stabilization and cement columns, Lime stabilization and lime columns. Stabilization using bitumen and emulsions, Stabilization using industrial wastes Construction techniques and applications.</p>	14
III	<p>Grouting : Permeation grouting, compaction grouting, jet grouting, different varieties of grout materials, grouting under difficult conditions.</p> <p>In situ soil treatment methods : Soil nailing, rock anchoring, micro, piles, design methods, construction techniques.</p> <p>Case studies : Case studies of ground improvement projects.</p>	14

Reference Books:

1. Manfried R. Hausmann, *Engineering Principles of Ground Modification*, McGraw-Hill Pub, Co., 1990.
2. Bowels, J. E, *Foundation Analysis and Design*, McGraw-Hill International Edition Singapore, 1997
3. Moseley, M. P, *Ground Improvement*, Blackie Academic & Professional, BocaRaton, Florida, USA, 1993
4. Teng, W. C, *Foundation Design*, Prentice Hall of India Pvt. Ltd

MTEC00010 : INTRODUCTION TO REMOTE SENSING AND GIS

Credits: 04

Semester - II

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	<p>Remote sensing : Physics of remote sensing, Ideal remote sensing system, Remote sensing satellites and their data products, Sensors and orbital characteristics, Spectral reflectance curves, resolution and multiconcept, FCC, Interpretation of remote sensing images.</p> <p>Digital image processing : Satellite image, characteristics and formats, Image histogram, Introduction to image rectification, Image enhancement, Land use and land cover classification system.</p>	12
II	<p>Geographic information system (GIS) : Basic concept of geographic data, GIS and its components, Data acquisition, Raster and vector formats, Topography and data models, Spatial modeling, Data output, GIS applications.</p>	14
III	<p>Global positioning system (GPS) : Introduction, Satellite navigation system, GPS, space segment, Control segment, User segment, GPS satellite signals, Receivers; Static, Kinematic and Differential GPS.</p> <p>Applications in Transportation Engineering : Intelligent Transport System, Urban Transport Planning, Accident Studies, Transport System Management, Road Network Planning, Collecting Road Inventory.</p>	14

Reference Books:

1. C.P LO Albert KW Yeung, *Concepts and techniques of Geographic Information Systems*, Printice Hall of India, 2002.
2. C.S. Agrawal& P K Garg, *Text Book on Remote Sensing*, Wheeler First.
3. Paul A. Longley, M. Goodchild, David Maguire, David Rhind, *Geographic Information Systems and Science*, Wiley, First.
4. Keith C. Clerk, BradelyO Parks, Michel P Crane, *Geographic Informaiton System and Enviornment Modeling*, Printicece Hall of India, 2002.
5. John R Jensen, *Remote Sensing of the Environment ..an Earth Resource Perspective*, Pearson Education, 2006.

MTEC0801 : APPLICATION OF REMOTE SENSING & GIS IN TRANSPORTATION ENGINEERING

Credits: 02

Semester - II

L-T-P: 0-0-4

Module No.	Contents	Teaching Hours
I	<ul style="list-style-type: none">• Spatial Digital Data and its Formats• Digital Image analysis (rectification, enhancement, FCC)• Image Classification• Vector Data generation, topology building and attribution• Generation of Contour, DEM, TIN• Overlay, Buffer and Network analysis• Models for Resource analysis.	52

SEMESTER - III

MTEC0802 : COMPUTER AIDED TRANSPORTATION ENGINEERING LAB

Credits: 04

Semester - III

L-T-P: 0-0-4

Module No.	Contents	Teaching Hours
I	Hands on practice on Transportation Engineering Drafting Softwares: <ul style="list-style-type: none">• Mx Road• OpenRoads• HDM4,	52

Reference Books:

1. <https://communities.bentley.com/products/road.../video-replace-reference>
2. World Road Association, Guidelines for HDM – 4 Software, (2004)

ELECTIVE - I

MTEE0001 : HIGHWAY CONSTRUCTION, QUALITY CONTROL AND MAINTENANCE

Credits: 04

Semester – I

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	Highway Construction : Types of Highway Construction, Earthwork specifications, Equipments , Types and Construction of Bituminous Pavements, Guidelines for construction of Cement Concrete Pavement	16
II	Management Of Quality : Organisation for Quality Assurance, Duties and Responsibilities, Methods Statement, Working Drawings, Review, Revision and Recording of Drawings, Site Inspections, Daily Reports and Diaries, Daily Inspection Reports, Field Inspection Diaries Quality Assurance Plan : Quality Control, Types of Quality Control, Performance of Quality Control, Testing Facilities, Test Specification and Frquencies, Method Control, Quality Parameters, Reporting of Test Results, Interpretation Test Results	12
III	Scope of Operation & Maintenance : Requirements, Organisation Structure & Key Personnel, Ordinary Repairs, Periodic Renewal, Special Repairs, Flood Damages and Emergency Repairs, Inspection	12

Reference Books:

1. NATIONAL HIGHWAYS AUTHORITY OF INDIA, *Manual of Specifications & Standards*, (2006)
2. NATIONAL HIGHWAYS AUTHORITY OF INDIA, *NHAI WORKS MANUAL*, (2006)
3. NATIONAL HIGHWAYS AUTHORITY OF INDIA, *QUALITY ASSURANCE MANUAL*, (2006)
4. NATIONAL HIGHWAYS AUTHORITY OF INDIA, *Quality Audit Manual (QAM) Volume - I*, (2001)
5. NATIONAL HIGHWAYS AUTHORITY OF INDIA, *Operations & Maintenance Manual*, (2015)
6. Khanna, S. K. and Justo C. E. G., *Highway Engineering*, Roorkee, Nemchand Bros. (2001).

MTEE0002 : INTELLIGENT TRANSPORTATION SYSTEM

Credits: 04

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	<p>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.</p> <p>Telecommunications in ITS : Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Vehicle, Road side communication, Vehicle Positioning System</p>	12
II	<p>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).</p> <p>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.</p>	14
III	<p>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.</p>	14

Reference 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.

MTEE0003 : AIRPORT PLANNING AND DESIGN

Credits: 04

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	Aircraft characteristics: Aircraft characteristics related to airport design; Airport configuration – Runway configurations, Relation of terminal area to runways, Runway orientation, Wind rose diagram. Geometric design of the airfield: ICAO and FAA design standards, Runways, Taxiways, Holding aprons and aprons	13
II	Planning and design of the terminal area: Apron-gate system, Size and number of gates, Aircraft parking configurations, Passenger terminal system. Design of Runway & Taxiways	13
III	Airport lighting and marking Air traffic control; Airport planning and air travel demand forecasting	14

Reference Books/ Text Books / Case Studies:

1. Rao, G.V, Airport Planning and Design, Tata McGrawHill, (1992)
2. Saxena S. C., Airport Engineering (Planning and Design), New Delhi CBS Publications & Distributors (2015).
3. Khanna and Arora, *Airport Planning and Design*, New Delhi, Dhanpat Rai & Sons (2015).

MTEE0004 : ADVANCED CONCRETE TECHNOLOGY

Credits: 04

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	<p>Introduction: different types of cementitious materials, different types of cements and pozzolanas, energy efficient cement burning technologies.</p> <p>Admixtures and Construction Chemicals: Benefits of admixtures, type of admixtures, plasticizers, action of plasticizers, super- plasticizers, classification of super plasticizers, effect of super-plasticizers, doses of super plasticizers, super plasticizers-cement compatibility, waterproofing admixture, antibacterial and similar admixtures.</p>	12
II	<p>Strength of Concrete: Factors affecting the strength, curing of concrete, autogenous healing, strength in tension, failure in compression, failure under multiaxial stress, micro cracking, aggregate cement paste interface, effect of age on strength of concrete, relationship between compressive and tensile strength, bond between concrete and reinforcement, failure strength of concrete, impact strength, electrical and accoustic properties of concrete, temperature effects in concrete.</p> <p>Durability of Concrete: Causes of inadequate durability, transportation mechanism in concrete, diffusion, absorption, water permeability of concrete, air and vapour permeability, carbonation, acid attack on concrete, sulphate attack on concrete, efflorescence, effect of sea water on concrete, alkali-silica reaction, type of cracking, action of frost, air entrainment, effect of de-icing agent, chloride attack, threshold content of chloride ions, influence of blended cement on corrosion, other factors affecting corrosion of reinforcement, test for penetrability of concrete to chlorides, stopping corrosion</p>	14
III	<p>FEM for Two and Three Dimensional Solids: Constant Strain Triangle, Linear Strain Triangle, Rectangular Elements, Numerical Evaluation of Element Stiffness, Computation of Stresses, Geometric Nonlinearity and Static Condensation, Axisymmetric Element, Finite Element Formulation of Axisymmetric Element, Finite Element Formulation for 3 Dimensional Elements</p> <p>Introduction to Plates and Shells</p>	14

Reference Books:

1. A. M. Neville, Properties of Concrete, Pearson education.
2. Performance Criteria for Concrete Durability, E & F N Spon, London.- J. Kroop and H.K.Hilsdorf
3. Concrete for High Temperature, Maclaren and sons, London- A.Petzold&M.Rohrs
4. Concrete Construction Engineering Hand Book, CRC Press, New York.- Edward G Nawy,
5. Concrete Technology, theory and Practice, S.Chand- M. S. Shetty
6. Concrete Technology, Theory and Practice, McGraw Hill.- M. L. Gambhir
7. Concrete, Tata Mc Graw Hill.,- P.K.Mehta & Paulo J.M.Monterio
8. Advances in Cement Technology, Tech Book International, New Delhi.-S.N.Ghosh

MTEE0005 : FINITE ELEMENT METHOD

Credits: 04

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	Introduction to Finite Element Analysis: Introduction Basic Concepts of Finite Element Analysis Introduction to Elasticity Steps in Finite Element Analysis Finite Element Formulation Techniques: Virtual Work and Variational Principle, Galerkin Method, Finite Element Method: Displacement Approach, Stiffness Matrix and Boundary Conditions	12
II	Element Properties: Natural Coordinates, Triangular Elements, Rectangular Elements, Lagrange and Serendipity Elements, Solid Elements, Isoparametric Formulation, Stiffness Matrix of Isoparametric Elements, Numerical Integration: One Dimensional. Numerical Integration: Two and Three Dimensional Analysis of Frame Structures: Stiffness of Truss Members, Analysis of Truss, Stiffness of Beam Members, Finite Element Analysis of Continuous Beam, Plane Frame Analysis, Analysis of Grid and Space Frame	16
III	FEM for Two and Three Dimensional Solids: Constant Strain Triangle, Linear Strain Triangle, Rectangular Elements, Numerical Evaluation of Element Stiffness, Computation of Stresses, Geometric Nonlinearity and Static Condensation, Axisymmetric Element, Finite Element Formulation of Axisymmetric Element, Finite Element Formulation for 3 Dimensional Elements Introduction to Plates and Shells	12

Reference Books:

1. Finite Element Method for Engineers and scientists – O.C.Zienkiewicz
2. Numerical Methods in Finite Element Analysis – K.J.Bathe&E.L.Wilson
3. Matrix Computations for Engineers & scientists – Alan Jennings
4. Introduction to Finite Element Method – C.S.Desai&J.F.Abel 5. Finite Element Method in Engineering – S.S. Rao

ELECTIVE - II

MTEE0006 : DESIGN OF REINFORCED CONCRETE BRIDGES

Credits: 04

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	Bridges : Components of Bridges, Classification, Importance of Bridges, Investigation for Bridges, Selection of Bridge site, Economical span, Location of piers and abutments, Subsoil exploration, Scour depth, Traffic projection, Choice of bridge type Specification of road bridges : width of carriageway, loads to be considered, dead load, IRC standard live load, Impact effect	12
II	General design considerations : Design of culvert, Foot bridge, slab bridge, T,beam bridge, Pre,stressed concrete bridge, Box Culvert, Fly over bridges	14
III	Evaluation of sub structures : Pier and abutments caps, Design of pier, Abutments, Type of foundations Importance of Bearings : Bearings for slab bridges, Bearings for girder bridges, Electrometric bearing, Joints, Expansion joints Construction and Maintenance of bridges , Lessons from bridge failures	14

Reference Books/ Text Book / Cases:

1. Ponnuswamy, S., *Bridge Engineering*, Tata McGraw, Hill, New Delhi, 1997
2. Victor, D.J., *Essentials of Bridge Engineering*, Oxford & IBH Publishers Co., New Delhi, 1980.
3. N. Rajagopalan, *Bridge Superstructure*, Narosa Publishing House, New Delhi, 2006.

MTEE0007 : SOIL STRUCTURE INTERACTION

Credits: 04

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	Introduction to soil-foundation interaction problems, idealized soil behavior, foundation behavior, interface behavior, analytical techniques, scope of soil-foundation interaction analysis. Idealized soil response models for the analysis of soil-foundation interaction: Elastic models of soil behavior, Winkler model, elastic continuum model, homogeneous and non-homogeneous elastic continuum, isotropic and anisotropic elastic continuum, orthotropic elastic continuum, layered and structured elastic medium. Two parameter elastic models: Filonenko-Borodich model, Paternak model, Hetenyi model, Vlazov model and Reissner model.	14
II	Elastic –plastic and time dependent behavior. Plane-strain analysis of an infinitely long beam and an infinite plate; analysis of beam of finite length under different loading conditions.	14
III	Analysis of circular and rectangular plates on elastic foundations. Settlement analysis of single pile: Load transfer method, analysis based on elastic theory, settlement of pile groups, load deflection prediction for laterally loaded piles, Pile raft system, dynamic loads on piles. Flexural behavior of axially and laterally loaded piles.	12

Reference Books:

1. Analytical and Computer Methods in Foundation, McGraw Hill.- Bowels J.E.
2. Elastic Analysis of Soil-Foundation Interaction, Elsevier. -Selvadurai, A. P. S
3. Pile Foundation Analysis and Design, John Wiley- Poulos H. G. and Davis E. H.
4. Foundation analysis and design, McGraw Hill.- Bowles J.E.
5. Foundation Analysis, Prentice Hall.- Scott R. F.
6. Numerical Methods in Geotechnical Engineering, McGraw Hill.-Desai C.S.& Christian J.T.,

MTEE0008 : ROAD MATERIALS AND NEW INNOVATIONS IN PAVEMENT ENGINEERING

Credits: 04

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	<p>Aggregate: Nature and properties, aggregate requirements, types and processing, aggregates for pavement base, aggregate for bituminous mixture, aggregate for Portland Cement Concrete, light weight aggregate, tests on aggregate, specification.</p> <p>Bituminous Materials: conventional and modified binders, production, types and grade, physical and chemical properties and uses, types of asphalt pavement construction, principles of bituminous pavement construction, tests on bituminous materials. Bituminous Mix design, modified mixtures, temperature susceptibility and performance.</p>	12
II	<p>Cement /concrete based materials: Cement, properties, PCC mix design and properties, modified PCC, Mix Design, Behaviour, Performance, Tests on Cement and Concrete mixes. High Performance Concrete, low shrinkage, increased strength.</p>	14
III	<p>Composites, Plastics and Geosynthetics: Plastics and polymerization process, properties, durability and chemical composition, Reinforced Polymer Composites, Geosynthetics, Dry Powdered Polymers, Enzymes.</p> <p>Reclaimed/Recycled Waste Products: Reclaimed Materials, waste products in civil engineering applications, effect of waste products on materials, structure and properties, self-healing and smart materials, locally available materials.</p>	14

Reference Books:

1. P. T. Sherwood, *Alternative Materials in Road Construction*, Thomas Telford Publication, London, 1997.
2. RRL, DSIR, *Soil Mechanics for Road Engineers*, HMSO, London, 1995
3. Koerner, R. M. *Designing with Geosynthetics*, Prentice Hall, Englewood Cliffs, New Jersey, U.S.A.
4. Shan Somayaji, *Civil Engineering Materials*, second edition, Prentice Hall Inc., 2001.

MTEE0009 : HIGHWAY CONSTRUCTION PRACTICE

Credits: 04

L-T-P: 4-0-0

Module No.	Contents	Teaching Hours
I	Embankment Construction: Formation cutting in Soil and hard rock, Preparation of Subgrade, Ground improvement, Retaining and Breast walls on hill roads, Granular and Stabilized Sub bases / bases, Water Bound Macadam (WBM), Wet Mix Macadam (WMM), Cement treated bases, Dry Lean Concrete (DLC).	12
II	Bituminous Constructions: Types of Bituminous Constructions, Interface Treatments, Bituminous Surfacing and wearing Courses for roads and bridge deck slabs, Selection of wearing Course under different Climatic and Traffic conditions, IRC specifications, Construction techniques and Quality Control.	14
III	Concrete road construction: Test on Concrete mixes, Construction equipments, Method of construction of joints in concrete pavements, Quality Control in Construction of Concrete pavements, Construction of Continuously reinforced, Prestressed, Steel Fibre Reinforced (SFRC) Pavements, IRC, MORT&H, ACI Specifications, AASHTO Specifications, Recycled pavements, Non, Conventional Pavements, Overlay Construction. Hill Roads Construction: Stability of Slopes, Landslides, Causes and Control measures, Construction of Bituminous and Cement Concrete roads at high altitudes, Hill road drainage, Construction and maintenance problems and remedial measures.	14

Reference Books:

1. Latest IRC Codes
2. Guideline of MORT&H
3. Guidelines of AASHTO