Course Structure & Curriculum

For

M. Tech. in Transportation Engineering

From

Academic Session: 2017-18

Department of Civil Engineering
Motilal Nehru National Institute of Technology Allahabad
Prayagraj -211004 (India)

Course Structure for M.Tech. in Transportation Engineering

Date of Applicability: Session 2017 – 18 onwards

Course Name: M.Tech (Transportation Engineering)

Eligibility: 1. First Class B.E./ B.Tech. in Civil Engineering, Civil Engineering & Planning, Civil Environmental Engineering, Civil Technology, Construction Engineering, Construction Technology, Environment & Pollution Control, Environmental Engineering and Environmental Science & Engineering
2. Valid GATE Score

First Semester

S. No.	Proposed Course No.	Subject Name	Credits	L	T	P	Distribution of Marks (100)		
							TA	Mid	End
1	CE-21131	Transportation System Planning	**4**	**3**	**1**		**20**	**20**	**60**
2	CE-21231	Transportation Engineering Lab-I (Traffic Engineering and Field Studies Lab)	**4**	**0**	**0**	**6**	**50**	**0**	**50**
3	CE-21XXX	Elective I	**4**	**3**	**1**		**20**	**20**	**60**
4	CE-21XXX	Elective II	**4**	**3**	**1**		**20**	**20**	**60**
5	CE-21XXX	Elective III	**4**	**3**	**1**		**20**	**20**	**60**
		Total Credits	**20**						

Second Semester

S. No.	Proposed Course No.	Subject Name	Credits	L	T	P	Distribution of Marks (100)		
							TA	Mid	End
1	CE-22131	Pavement Design	**4**	**3**	**1**		**20**	**20**	**60**
2	CE-22232	Transportation Engineering Lab-II (Highway Material Characterization and Pavement Test Lab)	**4**	**0**	**0**	**6**	**50**	**0**	**50**
3	CE-22XXX	Elective IV	**4**	**3**	**1**		**20**	**20**	**60**
4	CE-22XXX	Elective V	**4**	**3**	**1**		**20**	**20**	**60**
5	CE-22XXX	Elective VI	**4**	**3**	**1**		**20**	**20**	**60**
		Total Credits	**20**						

Third Semester

S. No.	Course No.	Subject Name	Credits	Marks
1	CE-23666	Seminar/Mini Project	**4**	**100**
2	CE-23616	Thesis	**16**	**100**
		Total Credits	**20**	

Fourth Semester

S. No.	Course No.	Subject Name	Credits	Marks
1	CE-24616	Thesis	**20**	**100**
		Total Credits	**20**	
		Total Credits of all the Semesters	**80**	

Note:- The distribution of thesis evaluation marks will be as follows.

1. Supervisor(s) evaluation component : 60%
2. Oral Board evaluation component: 40%

LIST OF ELECTIVES

S. No.	Course Code	Semester-I (Odd)	S. No.	Course Code	Semester-II (Even)
		Elective I			**Elective IV**
1	CE-21376	Computational Methods in Transportation Engineering	1	CE-22386	Intersection Design
2	CE-21377	Railway Track Management System	2	CE-22387	Planning, Design and Construction of Rural Roads
3	CE-21378	Traffic and Transportation Structures	3	CE-22388	Road Safety
4	CE-21379	Transportation Economics	4	CE-22389	Traffic Flow Theory
5	CE-21380	Transportation Networks	5	CE-22390	Urban Mass Transit Systems
		Elective II			**Elective V**
1	CE-21381	Engineering and Entrepreneurship	1	CE-22391	Advanced Airport Engineering
2	CE-21382	Geotechnical Explorations	2	CE-22392	Advanced Highway Construction
3	CE-21383	Highway Geometric Design	3	CE-22393	Highway Maintenance and Management Systems
4	CE-21384	Logistics	4	CE-22394	Intelligent Transportation Systems
5	CE-21385	Transport Demand Management	5	CE-22395	Sustainable Transportation
		Elective III			**Elective VI**
1	CE-21303	Advanced Concrete Technology	1	CE-22304	Design of Bridges
2	MA-21302	Advanced Mathematics	2	CE-22358	Environmental Impact Assessment
3	CE-21111	Advanced Soil Mechanics	3	CE-22326	Finite Elements in Geotechnical Engineering
4	GI-21101	GIS Technology	4	GI-22303	LiDAR Technology
5	CE-21357	Soft Computing Methods in Engineering Problem Solving	5	CE-22301	Optimization Methods in Civil Engineering
6	CE-21304	Structural Health Monitoring	6	MA-22303	Statistical and Probabilistic Analysis

Course Curriculum

CE-21131 Transportation Systems Planning L-3, T-1, P-0; Credits-4

Unit 1: Introduction to transportation systems, Importance of transportation planning, social and economic impacts of transportation;

Unit 2: Transportation system and its environment; transportation planning process, transportation costs, transportation data and its survey, transportation demand.

Unit 3: Supply of transportation, decision making, sequential transportation systems planning: Trip Production, Trip distribution, modal split and traffic assignment,

Unit 4: Land use transportation planning, Urban Forms, Mobility and Activity Hierarchy, Lowery's model etc.

Unit 5: Travel demand management measures; Case studies.

Unit 6: Public transport planning, integration of different modes

References:

1. *Hutchinson, B.G., Principles of Urban Transportation Planning, McGraw Hill, N.Y.*
2. *Morlok, E.K., Introduction to Transportation Engineering and Planning, McGraw Hill, N.Y.*
3. *Dickey, John. W., Metropolitan Transportation Planning, McGraw Hill, N.Y.*
4. *William, W. Hay, An Introduction to Transportation Engineering, John Wiley and Sons*

CE-21231 Transportation Engineering Lab-I (Traffic Engineering and Field Studies Lab) L-0, T-0, P-6; Credits-4

Traffic Studies –I (Speed Studies)- Space mean speed, time mean speed, speed data-collection methods, analysis and interpretations.

(i) Spot Speed Studies by Enoscope/ Radar Gun.

Traffic Studies –II (Volume Studies)- Definitions, data collection, data analysis and representation.

(ii) Traffic Volume Studies at Mid Block Section of Roads

(iii) Traffic Volume Studies at Intersection

(iv) Video Graphic Technique for volume/speed studies

Traffic Studies –III (General Traffic Engineering Studies)- Definitions, purpose, survey methods, Data collection and result presentation.

(v) Origin and Destination survey

(vi) Parking Studies

(vii) Gap Acceptance Study for Vehicles

(viii) Speed and Delay Studies

Traffic Studies –IV (Software and scanning systems applications) Purpose, Working and Application

(ix) Roadway Data Collection Using Mobile Mapping System

(x) Accident Data Collection using terrestrial scanners

(xi) GIS Based Transport Planning using TransCAD

(xii) Highway Geometric Design using MxRoad/CAD Software

CE-22131 Pavement Design **L-3, T-1, P-0; Credits-4**

Unit 1: Type of pavements, road pavement and airport pavements, design factors.

Unit 2: Materials of construction, subgrade soils, stone aggregates, bituminous material and cement concrete their suitability and effects.

Unit 3: Stresses in Flexible Pavements: Analysis for stresses in homogeneous masses and layered systems, deflections, shear failures, equivalent wheel and axle loads. Design of flexible pavements empirical, semi empirical and theoretical methods, practical approach.

Unit 4: Design of Flexible Pavements: Loading characteristics static, impact and repeated loads, effects of dual wheels and tandem axles, area of contact and tyre pressure, modulus or California Bearing Ratio (CBR) for different layers, equivalent single wheel load, equivalent stress and equivalent deflection criterion, equivalent wheel load factors, climatic and environmental factors, CBR adopted in various countries, U.S. navy method. triaxial method, Mcleod method, Boussinesq's and Burmister's analysis and design method, triaxial method, design of flexible pavements, IRC method for flexible pavement design.

Unit 5: Analysis and Design of Rigid Pavements: Wheel load stresses, liquid and elastic soil subgrade, Westergaard's analysis, Bradbury's approach , Arlington test , Pickett's corner load theory and related charts, Westergaard's and Tomlinson' s analysis of warping stresses, combination of stresses due to different causes, effect of temperature variation on rigid pavements, Prestressed concrete slabs-general details, design of tie bars and dowel bars IRC method for the design of rigid pavements.

Unit 6: Evaluation of existing pavements and their strengthening for future use.

References:

1. *Yoder and Whitejack, Pavement Design, John Wiley & Sons.*
2. *Flaherty, O. Highways-Location Design, Construction and Maintenance of Pavements, Taylor and Francis.*
3. *S.K. Khanna and C.E.G. Justo, Highways Engineering, Nem Chand and Bros.*
4. *Rajib B. Mallick and Tahar El-Korchi - Pavement Engineering: Principles and Practice.*
5. *IRC: 37-2001, "Guidelines for the Design of Flexible Pavements (Second Revision)".*
6. *IRC: 58-2001, "Guidelines for the Design of Plain Jointed Rigid Pavements for Highways (Second Revision)".*
7. *AASHTO – Design of pavement Structures*

CE- 22232 Transportation Engineering Lab-II (Highway Material Characterization and Pavement Test Lab) **L-0, T-0, P-6; Credits-4**

(i) Review tests on aggregates
(ii) Review test on bitumen
(iii) Marshall's Method of Bituminous Mix Design
(iv) Estimation of soil CBR for road purpose
(v) Estimation of soil CBR by Dynamic Cone Penetration (DPT) Test
(vi) Pavement Evaluation using Benkelmen Beam
(vii) Bitumen Content Estimation using Ele Content Tester
(viii) Road unevenness evaluation using Bump Integrator
(ix) Pavement Surface Roughness Estimation using Friction Tester
(x) Plate load test

Syllabus of List of Electives in Transportation Engineering for Semester-I
(Odd Semester)

CE-21376 Computational Methods in Transportation Engineering

L-3, T-1, P-0 Credits-4

Unit 1: Introduction-Basic Concepts, Computation Problems and Tools in Transportation Engineering, Software in Transportation Engineering: Computer Architecture, Development Approaches, Applications, and Benchmarking.
Unit 2: Programming Concepts: Programming in Visual C++ using object oriented programming concepts, Programming in GIS Environment, Data Structures and Complexity Analysis, Expert Systems and their development, Development of computer programs for geometric and pavement design based on OOP Concepts.
Unit 3: Data Collection, Modelling and Database Design for Transportation-Transportation data and their sources, collection process, Database development process, Transportation Data models, Data Modelling using UML, Linear referencing methods, Advanced dynamic segmentation functions, Database Models for Transportation Planning, Pavement Management, Public Transportation, Incident Management, Logistics and Navigation Services etc., Case Studies.
Unit 4: Geometrical Modelling of Highway Networks-Introduction, Geometric modelling of highways, Road Alignment Models, Designing in 2D using alignments, Designing vertical profiles, modelling the existing terrain using Surfaces, Designing roads corridors in 3D, Geoinformatics applications for Geometrical Modelling of roads.
Unit 5: Optimization for Network Flows-Modelling network flows on network, shortest path algorithms, nearest neighbour algorithms, minimum spanning tree algorithms and algorithms for static and dynamic traffic assignment, Vehicle routing problem, Use of evolutionary algorithms for solving flow problems.
Unit 6: Modellling and Simulation Concepts-Basic Simulation Modeling, Modeling Complex Systems, Microscopic Traffic Flow Modelling using Cellular Automata and Agent Based Approaches, Fuzzy Logic Approach for car following models, Simulation Software for Traffic Flow Modelling: VISSIM, Avenue and Paramics,

References:

1. *Averill M. Law, Simulation Modeling and Analysis, Tata McGraw Hill.*
2. *Benny Raphael and Ian F.C. Smith, Engineering Informatics: Fundamentals of Computer-Aided Engineering, Wiley.*
3. *Eric Chappell , AutoCAD® Civil 3D Essentials, Wiley*
4. *Harvey J. Miller and Shih-Lung Shaw, Geographic Information Systems for Transportation: Principles and Applications, Oxford University Press.*
5. *J. Allison Butler,Designing Geodatabases for Transportation, ESRI Press.*
6. *Jaume Barceló (ed), Fundamentals of Traffic Simulation, Springer*
7. *Timothy Ross, Fuzzy Logic with Engineering Applications*
8. *M.K. Jha, P. Schonfeld, J.-C. Jong, and E. Kim, Intelligent Road Design, WIT Press.*
9. *Ulrik Brandes and Thomas Erleback (eds.), Network Analysis: Methodological Foundations, Springer.*

CE-21377 Railway Track Management System L-3, T-1, P-0, Credits-4

Unit 1: Development and importance of rail transportation. Advanced aspects of traffic surveys and route location.
Unit 2: Modern track Construction and renewal of tracks; Rail-wheel interaction.
Unit 3: High speed track - current status, construction parameters, monitoring, maintenance, other requisites. Track Stresses, Standards and Rehabilitation; Special tracks.
Unit 4: Maintenance of track - manual, mechanized and Track Management System;
Unit 5: Traffic operations and control; Urban rail transit; Rail terminal design; Integration of rail and road transport
Unit 6: Evaluation of rail projects; Modernisation and future trends.

References:

1. *J. S. Mundrey, Railway Track Engineering, Tata McGraw-Hill Education.*
2. *S. Chandra & M.M. Agarwal, Railway Engineering, Oxford University Press.*
3. *Saxena and Arora, Railway Engineering, Dhanpat Rai and Sons, Delhi 2. Agarwal, MM, Railway Engineering, CBS, Delhi.*
4. *Rangawala, Railway Engineering, Charotar Publishing House.*

CE-21378 Traffic and Transportation Structures L-3, T-1, P-0, Credits-4

Unit 1: Introduction to traffic and transportation structures; Bridges, Flyovers, Tunnels, Retaining Walls, Docks, Harbours, Airport Structures
Unit 2: Earth Retaining Structures: lateral earth pressure, retaining wall types, analysis of backfilled walls and in-situ walls, stability of wall and base, settlements due to excavation, strut and anchor systems, diaphragm walls: slurry control, concrete technology, instrumentation for deep excavation.
Unit 3: Construction and Design of Tunnels: Site investigations, Geotechnical consideration, Design of tunnels, Construction and excavation methods of Soft ground tunnels and rock tunnels, Micro tunneling techniques, Ventilation and Safety.
Unit 4: Design of Harbours and Docks: Harbours: Requirements, Classification, Location and Design Principles – Harbour Layout and Terminal Facilities, Coastal Structures: Piers, Break waters, Wharves, Jetties, Quays, Spring Fenders, Dolphins and Floating Landing Stage, Inland Water Transport.
Unit 5: Design of Flyovers and Subways
Unit 6: Design of Cross drainage Works for roads: Siting or locating, hydrological aspect and design.

References:

1. *Narsimha Rao, Bridges and Flyovers, International Book House, Delhi*
2. *Paul Andersen, Statically Indeterminate Structures, Ronald Press Company, New York.*
3. *Ponnuswamy S., Bridge Engineering, Tata McGraw-Hill Publishing Company, 1990.*
4. *D. Johnson Victor, Essentials of bridge Engineering, Oxford & IBH Publishing Co. Pvt. Ltd.*
5. *Relevant IRC Codes.*

CE-21379 Transportation Economics L-3, T-1, P-0, Credits-4

Unit 1: Introduction to transport economics, Economic theory, transport as an economic activity.
Unit 2: Demand forecasting methods, factors influencing transport demand, direct and cross-price Elasticities of demand, factors that cause shifts in demand function. Direct and External costs of transport, concept of generalised costs, social aspects of transport, joint and common costs of infrastructure, short-term and long-term costs of supply, Congestion costs, External costs.
Unit 3: Pricing of Transport Services, The marginal cost pricing rule, Efficient pricing, cost complexities and cost recovery, Peak-load pricing, Second-best pricing, Transport subsidies, Price discrimination, Congestion pricing
Unit 4: Regulation of Supply of Transport Capacity, Command and control type of regulation, fiscal measures such as road pricing and environmental taxation, Safety and economic regulations in the context of transport services provided by public, issues of social, geographical and temporal equity.
Unit 5: Appraisal and Evaluation of Transport Projects: Feasibility and evaluation, cost, impacts and performance levels, evaluation of alternatives, analysis techniques, cost-benefit analysis, social and financial benefits, valuation of time, measures of land value and consumer benefits from transportation projects, prioritization of projects, multi-criteria decision assessment.
Unit 6: Methods for raising funds for maintenance, improvement and expansion of transportation networks: - taxation and user fee, Financing through loans, bonds, PPPs and concessions.

References:

1. *André De Palma, Robin Lindsey and Emile Quine, Handbook of Transport Economics, Edward Elgar Pub.*
2. *Patrick McCarthy, Transportation Economics: Theory and Practice,Wiley-Blackwell*
3. *Kenneth Small and Erik Verhoef, The Economics of Urban Transportation, Routledge.*

CE-21380 Transportation Networks **L-3, T-1, P-0, Credits-4**

Unit 1: Introduction: Concept of Supply, Demand, Time and Space, Networks Classifications, Concepts of Hierarchy, Topology and Sequence.
Unit 2: Elements of Network Theory: Graphs, Flows, Cost and Capacities, Capacitated Networks, Geometric Networks, Linear Referencing Systems for transportation networks.
Unit 3: Basic Network Problems: Minimum Cost, Maximum Flow, Arc Routing, Minimum Spanning Tree, Shortest Path, Travelling Salesman.
Unit 4: Advance Network Problems: Vehicle Routing, Traffic Assignment Problems, Nearest Neighbour, Service Area Analysis, Location-Allocation.
Unit 5: Transportation Network for Public Transportation: Planning and Scheduling Algorithms, Multimodal Networks.
Unit 6: Software Application and Case Studies: Modelling and Analysis of Transportation Networks using software like ArcGIS Network Analyst, TransCAD, Operational Research (OR) Packages, Heuristic Labs etc. and Case Studies.

References:

1. *F. Xie and D. Levinson, Evolving Transportation Networks, Springer.*
2. *J Evans, Optimization Algorithms for Networks and Graphs, Marcel Dekker.*
3. *P. Mathis (ed), Graphs and Networks, ISTE Ltd and Wiley.*
4. *R.F. Potts and R.M. Oliver, Flows in Transportation Networks, Academic Press.*
5. *R.K. Ahuja, T.L. Magnanti, and J.B. Orlin, Network Flows: Theory, Algorithms, and Applications, Prentice-Hall.*
6. *Software Manuals of ArcGIS, TransCAD, Heuristic Labs.*

CE-21381 Engineering and Entrepreneurship L-3, T-1, P-0, Credits-4

Unit 1: Definition, requirements to be an entrepreneur, Entrepreneur and Manager, growth of entrepreneurship in India, Rural and Urban entrepreneurship.
Unit 2: The Greatest Salesman in the World, The Tao of Warren Buffett, Personal Freedom, Creating Affluence, Creativity, Habits of Highly Effective People, Goals (HW) How to Win Friends & Influence People, Success, Yes! Attitude, Own Your Own Corporation, The Unwritten Laws of Business, Leadership, Developing the Leader qualities,
Unit 3: Types of Enterprises and Ownership Structure: Small Scale, medium scale and large scale enterprises, role of small enterprises in economic development; proprietorship, partnership, Ltd. companies and co-operatives: their formation, capital structure and source of finance.
Unit 4: Identification and selection of projects; The ABC's of Writing Winning Business Plans, project report: contents and formulation, concept of project evaluation, methods of project evaluation: internal rate of return method and net present value method.
Unit 5: Management of Enterprises: objectives and functions of management, scientific management, general and strategic management; Get Everyone In Your Boat Rowing in the Right Direction, Negotiation Skills introduction to human resource management: planning, job analysis, training, recruitment and selection, etc.; marketing and organizational dimension of enterprises;
Unit 6: Enterprise financing: raising and managing capital, shares, debentures and bonds, cost of capital; break- even analysis, balance sheet its analysis..

References

1. *K. Uchino, Entrepreneurship for Engineers, CRC Press.*
2. *Ram Chandran, 'Entrepreneurial Development', Tata McGraw Hill, New Delhi*
3. *Vasant Desai,, ' Project Management and Entrepreneurship', Himalayan Publishing House, Mumbai, 2002.*
4. *Boylan, Bob, Get Everyone in Your Boat Rowing in the Same Direction (New York: Barnes and Noble Books, 1995).*
5. *Chopra, Deepak, M.D. Creating Affluence: Wealth Consciousness in the Field of All Possibilities (California: New World Library, 1993).*
6. *Clason, George S., The Richest Man in Babylon (New York: Signet, 1998).*
7. *Collins, Jim, Good To Great: Why Some Companies Make the Leap... and Others Don't (New York: Harper Business, HarperCollins Publishers, Inc., 2001).*
8. *Business, Harper Collins Publishers, Inc., 2004).*
9. *Fisher, Roger and Daniel Shapiro, Beyond Reason: Using Emotions as You Negotiate*
10. *Goldberg, David E., The Entrepreneurial Engineer (New York: John Wiley & Sons, Inc., 2006).*

CE-22382 Geotechnical Explorations L-3, T-1, P-0, Credits-4

Unit 1: Engineering properties of soil: Relevant theoretical concepts for determination of engineering properties of soils, Need and importance of site investigation, Methods of site exploration, Procuring and handling of disturbed and un-disturbed samples.
Unit 2: Subsurface exploration: Subsurface exploration, planning, drilling and sampling techniques. Demonstration of drilling equipments.
Unit 3: Test for Shear Strength Determination: Soil testing techniques to determine the shear strength properties of soil by direct shear test, unconfined compression test, vane shear test, triaxial tests. Determination of total and effective stress parameters. Determination of compaction and consolidation characteristics. Demonstration of shear strength tests in laboratory.
Unit 4: In-situ tests: In-situ field testing and laboratory investigation of soil, including advanced equipments, instrumentation, data acquisition, and measurement techniques: SPT, CPT, DCPT, Pressuremeter, Dilatometer, Permeability, etc.
Unit 5: Data Interpretation: Data interpretations for determination of engineering properties of soils, and their application to geotechnical design. Preparation of site-investigation reports. Demonstration of tests.

Unit 6: Geophysical Methods: Cross hole Tests, Down hole Tests, Spectral Analysis of Surface Waves, Seismic Refraction, Suspension Logging, Ground Penetrating Radar (GPR), Electromagnetic Conductivity (EM), Surface Resistivity (SR), Magnetometer Surveys, Gravity Method

References

1. *Soil Testing and Exploration- Alam Singh,. Asia Publishing House.*
2. *Soil Testing for Engineers- T.W. Lambe, pub. John wiley& Sons.*
3. *Gopal Ranjan and A.S.R. Rao: Basic and Applied Soil Mechanics, pub. New Age International Publishers.*
4. *Purushotama Raj: Geotechnical Engineering, pub. Pearson Education.*
5. *V. N. S. Murthy: Geotechnical Engineering, pub. CRC press.*

CE-21383 Highways Geometric Design L-3, T-1, P-0, Credits-4

Unit 1: Highway functional classification, Single lane, two lane, four lane, six lane highways, expressways, freeways, Topography and physical features, traffic, impact of vehicular characteristics on road geometrics, speed and safety,

Unit 2: Traffic characteristics, highway capacity, HCM, USA, access control, safety, environment.

Unit 3: Elements of design, sight distance, Horizontal curve design, maximum curvature, super elevation rates, transition curves, attainment of super elevation, pavement widening, sight distance on horizontal curves and side friction, Gradients, compensation of grade at curves, design of climbing lanes, shape of vertical curves, design of summit and valley curves, design of speed breaker, combination of horizontal and vertical alignment.

Unit 4: Intersection and roundabouts and their capacity analysis, major and minor interchanges,

Unit 5: Geometric Design of Entrance and exit ramps, acceleration lanes.

Unit 6: Demand analysis, parking space configuration and requirements, on street and off street layout, multilevel parking, automatic/semi -automatic parking structures, Geometric Design of public transport facilities and parking facilities.

References

1. *Highway Capacity Manual, 4th Edition, Transportation Research Board, Washington DC, 2000.*
2. *A Policy on Geometric Design of Highways and Streets, 4th Edition, American Association of State Highway and Traffic Officials, Washington, DC, 2001.*
3. *Roess, R.P., Prassas, E. and McShane,W.R., Traffic Engineering, Pearson Publication, 2004.*
4. *IRC:52-1981, Recommendations About the Alignment Survey and geometric Design of Hill Roads (First Revision)*
5. *IRC:73-1980, Geometric Design Standards for Rural (Non-Urban) Highways.*
6. *IRC:86-1983, Geometric Design Standard for Urban Roads in Plains.*

CE-22384 Logistics **L-3, T-1, P-0, Credits-4**

Unit 1: Introduction to logistics and distribution: Definition, Scope, Historical Perspective Importance of Logistics, Economic Impact of Logistics, Transportation, Inventory, and production costs, Logistic Activities.
Unit 2: Mathematical Tools for Logistics: Mathematical Programming, Heuristic Algorithms, Fuzzy Logic and GA Approaches
Unit 3: Logistics Matrices: Attribute Data in the Logistics Area, Variable Data in the Logistics Area, Statistical Methods of Process Monitoring, Logistics Performance Metrics
Unit 4: Demand Forecasting Methods: Qualitative, Quantitative, Advance Forecasting Methods,
Unit 5: Logistics network planning: Network Models and Components
Unit 6: Transportation and Facility Location: Planning and Managing Short Haul and Long Haul Transportation, Facility Location Model, Case Studies.

References:

1. *G. D. Taylor, Logistics Engineering Handbook, CRC Press.*
2. *G. Ghiani , G. Laporte and R. Musmanno, Introduction to Logistics Systems Planning and Control, Wiley.*
3. *R. G. Kasilingam, Logistics and Transportation: Design and planning, Springer Science and Business Media.*

CE-21385 Transport Demand Management L-3, T-1, P-0, Credits -4

Unit 1: Introduction, TDM Framework, Social Inclusion.

Unit 2: Indicators for TDM Strategies: Mobility, Accessibility, Congestion, Operation Cost, Travel Time, Elasticities.

Unit 3: TDM Strategies for Congestion Reduction, Energy Conservation and Emission Reductions, Improving Equity, Parking, Rural Community TDM, Safety

Unit 4: TDM Strategies for Organizations and Stakeholder Groups: TDM Measures at Campus, Transport Agencies, Municipal, Regional, State Levels.

Unit 5: Assessment of TDM Strategies: Evaluation of Road User Charging, Purchase, Circulation and Fuel Taxation, Driving Rights, Intelligent Transportation Systems, Park and Ride etc.

Unit 6: TDM Best Practices: Planning, Implementation and Assessment.

References:

1. *Fiona Rajé, Transport, Demand Management, and Social inclusion: The Need for Ethnic Perspectives, Ashgate.*
2. *Online TDM Encyclopedia, Victoria Transport Institute.*
3. *Stephen Ison and Tom Rye (eds), The Implementation and Effectiveness of Transport Demand Management Measures, Ashgate.*
4. *Wafaa Saleh and Gerd Sammer (eds.), Travel Demand Management and Road User Pricing: Success, Failure and Feasibility, Ashgate.*
5. *Research Papers*

CE-21303 Advanced Concrete Technology L-3, T-1, P-0, Credits-4

Unit1. Introduction, different types of cementitious materials, energy efficient cement burning technologies. 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.

Unit 2. Strength of Concrete: Factors affecting the strength, curing of concrete, autogenious 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.

Unit 3. 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, efflorencence, 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

Unit 4. Special Concrete and Concreting Techniques : Introduction, light weight concrete, ultra light weight concrete, vacuum concrete, mass concrete, roller compacted concrete, concrete with different cementitious materials like flyash, ggbs, silica fume, rice husk ash, shotcrete or guniting, ferrocement, fiber reinforced concrete, polymer concrete composites, sulphur concrete, jet cement concrete, gap graded concrete, high performance concrete, self compacting concrete, foamed concrete.

Unit 5. Non-destructive testing of hardened concrete: Rebound hammer test, pull-out test, ultrasonic pulse velocity test, resonant frequency method.

References:

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

MA-21302 Advanced Mathematics L-3, T-1, P-0, Credits-4

Unit 1. Matrix Theory: Concept of Eigen values, Eigen vectors, decomposition of matrices, LU- Decomposition, Block LU decomposition, Rank factorization, Cholesky decomposition, LDU, LUP decomposition, QR decomposition, Eigen decomposition.
Unit 2. Partial Diff. Equation: Boundary and Initial Value Problems involving partial differential equations of the second order. Their solutions by the method of seperation of variables.
Unit 3. Numerical Solution of differential equations: Review of Numerical Methods for Solving Polynomial equations and simultaneous linear algebraic equation. Euler's method, modified Eulers method, Runge-Kutta Method, Predictor-Corrector Methods. Numerical Solution of Elliptic and Parabolic Partial differential equation.
Unit 4. Statistics: Probability basics, Special distributions: Bernoulli, Binomial, Geometric, Negative Binomial, Hypergeometric, Poisson, Uniform, Exponential, Gamma, Normal joint distributions, Marginal and conditional distributions, Moments, Independence of random variables, Covariance, Correlation. Regression Problem: Scatter diagram, Simple linear regression, Least squares estimation, multiple regressions**.**
Unit 5. Integral Transforms**:** Laplace Transforms. Transforms of derivatives, inverse transforms. Transforms of Dirac Delta function and Unit Step function, Their applications.
Unit 6. Variation of Calculus: Maxima and Minima of Functions of two three and more variables. Relative Maximum and Minimum value, Basic problems of Calculus of variation, Minimum energy problem, Applications of the Calculus of variation in engineering problems

References:

1. *Kreyszing, E., Advanced Engineering Mathematics, Wiley.*
2. *Martin, H. G., Mathematics for Engineering, Technology and Computing Science.*
3. *Jain, M.K., lyengar, S.R.K and Jain R.K. " Numerical methods for Scientific and Engineering Computations, New age International (P) Ltd. Publisher, New Delhi*
4. *Freund, J.E. and Miller, I.R., "Probability and Statistics for Engineers" Prentice- Hall of India.*

CE-21111 Advanced Soil Mechanics L-3, T-1, P-0, Credits-4

Unit 1: Structure and composition of soil &clay minerals, effect of clay minerals on engineering properties, mechanics of expansive soil.
Unit 2: Plane stress and plane strain problems as applied to geotechnical engineering.
Unit 3: Concentrated and distributed line loads: Boussinesq's equation and Westergaards's solution. Vertical pressure line and strip loads and loaded circular and rectangular areas. Limitations of elastic formulae for soils.
Unit 4: Concept of elastic and plastic equilibrium, general states of plastic equilibrium. Dubrova's lateral earth pressure theories, Brinch-Hansens theory.
Unit 5: Shear strength of cohesionless and cohesive soils,effective stress principle.
Unit 6: Theory of consolidation, Time rate of consolidation, 3-D consolidation, immediate and ultimate settlements.

References

1. *Advance Geotechnical Engg. - Alam Singh, pub. CBS Publishers and Distributors.*
2. *Theoretical Soil Mechanics- M. E. Harr, pub. Tata McGraw-Hill.*
3. *Theoretical Soil Mechanics -Jumikis, pub. R.E. Krieger Pub.*
4. *Theoretical Soil Mechanics -Terzagi, pub. John Wiley & Sons.*

GI-21101 GIS Technology **L-3, T-1, P-0, Credits-4**

Unit 1: Introduction to GIS, evolution of GIS, components of a GIS, introduction of geodesy, map reference systems.
Unit 2: Spatial and attribute data, data sources, maps, data acquisition – scanners and digitizers, models, structures, data editing, attribute data handling
Unit 3: Raster data analysis: reclassification, slope, aspect, viewshed analysis etc. vector data analysis: overlay operation, buffer analysis, and interpolation techniques. digital terrain modelling
Unit 4: Visualization data quality, GIS output, cartography, spatial decision support systems, GIS models, GIS planning and implementation
Unit 5: Introduction to GIS Software, Applications of GIS in different fields, topographical mapping in GIS platform, Case Studies of GIS.

References:

1. *Burrough, P.A. and McDonnell, R.A.," Principles of Geographical Information Systems ", Oxford University Press, 1998.*
2. *Ian Heywood, An introduction to geographical information systems, Pearson Education India, 2010*
3. *Kang-tsung Chang , Fundamental of Geographic Information Systems, Tata Mcgraw-Hill(TMH), 2009*
4. *Lo C.P. and Yeung A.K.W., Concepts and Techniques of Geographic Information Systems, Prentice-Hall, Inc., NJ, 2002.*

CE-21357 Soft Computing Methods in Engineering Problem Solving

L-3, T-1, P-0, Credits-4

Unit 1: Introduction and Working Principles. Back ground, definitions, classification of soft computing techniques, advantages, limitations; Working principles of soft computing techniques- Fuzzy, ANN, genetic algorithms and other evolutionary techniques', examples in real life.
Unit 2: Fuzzy systems. Fuzzy sets, fuzzy numbers, fuzzy relations, fuzzy measures, fuzzy logic and the theory of uncertainty and information; applications of the theory to inference and control, clustering, image processing and data handling.
Unit 3: Artificial Neural Networks. Theory of representation; Two computational paradigms: Multi-layer networks; Auto associative and heteroassociative nets; Learning in neural nets: Supervised and unsupervised learning; Application of neural nets; Neural network simulators.
Unit 4: Genetic Algorithm. Genetic algorithm and Traditional optimization methods; Simple genetic algorithms- reproduction, crossover and mutation; Analysis of GA-operators; Deception; Working principles of genetic algorithms; Multimodel and multiobjective optimization; Engineering applications; Introduction with applications for Evolution strategy.
Unit 5: Hybrid Systems. Necessity, combined use of Fuzzy and ANN; Neuro-fuzzy systems, application of Neuro-fuzzy systems; Combined use of ANN-GA.
Unit 6: Applications. Case studies and general applications in engineering applications
Term Paper: Based on applications and/or algorithms development.

References

1. *Bart, K., "Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence", Prentice Hall. Barto, A. G. 1985.*
2. *Deb, K., "Evolutionary Multiobjective Optimization Algorithms" John Wiley & Sons Ltd., 2001.*
3. *Goldberg, D. E., "Genetic Algorithms in Search, Optimization and Machine learning", Addison-Wesley Publishing Co., 1989.*
4. *Haykin, S., "Neural Networks: A Comprehensive Foundations", Macmillan College Publishing Company, New York, 1994.*
5. *Ross, T.J., "Fuzzy Logic with Engineering Applications", McGraw-Hill Inc., 1995.*
6. *Zurada, J.M., "Introduction to Artificial Neural Systems", West Publishing Company, New York, 1992.*

CE-21304 Structural Health Monitoring L-3, T-1, P-0, Credits-4

Unit 1. Introduction to structural health monitoring (SHM). Types of Sensor System and its application. Data acquisition system.
Unit 2. Various Techniques for SHM. Global and local techniques. Computational and Experimental aspect of global dynamic technique.
Unit 3. Smart Material and its application for SHM. Piezo-electric material and its application as sensor, actuator and transducer.
Unit 4. Electro-mechanical Impedance (EMI) Technique for SHM, its basic principle, application and limitation .
Unit 5. Low cost adaptations of EMI technique. Fatigue life assessment using EMI Technique.
Unit 6. Integration of global technique and EMI Technique and their validations.

Reference:

1. *Soh, C.K. Yang Y.W. and Bhalla S. Smart Material in Structural Health Monitoring, Control and Bio-Mechanics Springer, 2011*
2. *Ewins, D.J. Modal Testing: Theory, Practices and Applications, 2nd edition, Research Studies Press Ltd.,Baldock*

Syllabus of List of Electives in Transportation Engineering for Semester-II
(Even Semester)

CE 22386 Intersection Design **L-3, T-1, P-0, Credits-4**

Unit 1: Introduction, Types of Intersections, Elements of Intersection, Driver Behaviour at Intersection: Traffic Conflicts, Traffic Priority, Planning steps and Feasibility Assessment
Unit 2: Design of At-Grade Intersections: Layout, Design Principle: Alignment, Profile and Curves, Channelization, Capacity Determination, Sight Distance Requirements.
Unit 3: Design of Grade Seperated Intersections: Classification, Characteristics of grade separated structures. Design of Acceleration Lanes, Deaceleration Lanes, Overpass Underpass.
Unit 4: Intersection Control: General Concepts, Conflicts, Types of Intersection Control, Signal Design, Freeway Ramps
Unit 5: Capacity Analysis of Unsignalized and siganlized Intersections: LOS, Factors effecting Capacity, HCM and UK Method of Capacity Analysis.
Unit 6: Design of Roundabouts: Overview, Advantages and Disadvantages, Selection Guidelines, Traffic Operations, Design Elements, Capacity Analysis.

References:

1. *IRC:SP:41-1994, Guidelines on Design of At-Grade Intersections in Rural & Urban Areas.*
2. *N.J. Garber and L.A. Hoel, Traffic and Highway Engineering, Cengage Learning.*
3. *M. Rogers, Highway Engineering, Wiley*
4. *Highway Capacity Manual, Federal Highway Administration, 2010 Edition.*

CE-22387 Planning, Design and Construction of Rural Roads

L-3, T-1, P-0, Credits-4

Unit 1: Planning of Rural Roads: Classification of roads, brief introduction to earlier 20 year plans, system's approach, NATPAC model, gravity model, CRRI model, Accessibility Based Rural Network Planning model, concept of link efficiency, optimal road network planning approach.

Unit 2: Geometric Design: Geometric design standards for rural roads with special reference to PMGSY, hill road standards.

Unit 3: Pavement Design: Various pavement design methods for rural roads including flexible and rigid pavements using IRC:SP-20, IRC-72, IRC-37, IRC:SP-62, CRRI nomograms., Type and causes of road failures and their remedial measures

Unit 4: Materials and Mix design methods: Conventional materials, marginal and waste materials including fly ash, Granular Blast Furnace Slag (GBFS), Blast Furnace Slag (BFS), Steel Making Slag (SMS), bagasse and Crum Rubber Modified Binder (CRMB), etc. Mix Design Methods: CRRI method, triangular chart method, Fuller's method, Rothfuch method, PI based method.

Unit 5: Construction: Low cost techniques for rural road construction, tractor bound technology, special considerations for hill areas; Case studies of waste material utilization in rural roads

Unit 6: Drainage: Transverse and longitudinal drainage, design of drains, minor cross drainage works, filter design etc.

References:

1. *"Rural Roads Manual", SP-20, IRC. 2002*
2. *. "Document on Rural Road Development", Vol. I & II, CRRI. 1990*
3. *"PMGSY Operation Manual", NRRDA. 2005*
4. *"Specifications for Rural Roads", MoRD, IRC. 2004*
5. *Khanna, S.K. and Justo, C.E.G., "Highway Engineering", Nem Chand & Bros. 2004*
6. *Kadiyali, L.R., "Traffic Engineering and Transport Planning", Khanna Publishers. 1999*
7. *"Quality Assurance Handbook for Rural Roads", NRRDA*

CE-22388 Road Safety **L-3, T-1, P-0, Credits-4**

Unit 1: Introduction, factors contributing to road accidents, Accident rates for different types of exposure, Risk Factors for accident involvement, risk factors for injury severity, Human Factors in Road Safety: Driver Control Theory, Driver capacities and age effects, Driving style, Driver temporary impairments, control studies, Self Report Instruments and Methods
Unit 2: Road accident recording: Road accident collection and record system, Post accident reconstruction, IRC method for recording accident, use of GIS in recording and management of accident data
Unit 3: Accident investigation and analysis, Analysis of accident data and mathematical formulation, identification of hazardous road way sections and black spot. Spatial analysis of accident data using GIS
Unit 4: Road Safety Measures: Road Design and Road Equipments: Cycle Lane, Motorways, Bypasses. Roundabouts, Grade Separated Intersections, Road Alignment, Black Spots Treatments, Road Lighting, Horizontal Curve Treatments, Vehicle Design Elements for road safety, vision enhancement systems, adaptive braking systems, Traffic Calming Measures, Access and Signal Controls, Public Education
Unit 5: Road Safety Audits: Basic Concepts, Methods and Applications.
Unit 6: Road Safety Programmes: Identification of key parameters, methodology and implementation of programme.

References:

1. *L.J. Greenwood, Highway scene safety*
2. *Highway Safety Manual, AASHTO*
3. *Rune Elvik, Alena Høye, Truls Vaa and Michael Sørensen, Handbook of Road Safety Manual,Emerald Group Publishing Limited*
4. *D. Shinar, Traffic Safety and Human Behaviour,Elsevier.*
5. *B.E. Porter, Handbook of Traffic Psychology, Elseiver.*

CE-22389 Traffic Flow theory L-3, T-1, P-0, Credits-4

Unit 1: Traffic stream characteristics: Introduction to traffic engineering: Road user characteristics, human and vehicle characteristics; Fundamental parameters and relations of traffic flow: speed, density, volume, travel time, headway, spacing, time-space diagram, time mean speed, space mean speed and their relation, relation between speeds, flow, density, fundamental diagrams,

Unit 2: Traffic stream models: Greenshield's model, Greenberg's logarithmic model, Underwood's exponential model, pipe's generalized model, multi-regime models; Concepts and derivation, illustration, Calibration of Greenshild's model.

Unit 3: Microscopic traffic flow modelling: Car-following models; Vehicle arrival models: Poisson distribution, headway modeling, Microscopic traffic simulations.

Unit 4: Advanced Flow Theories: Shock waves in traffic streams: Types, Propagation; Gap Acceptance, Queuing Theory: Concepts and Applications.

Unit 5: Uninterrupted Flow: Characteristics of uninterrupted traffic, capacity and LOS of Uninterrupted facilities.

Unit 6: Interrupted Flow: Characteristics of Interrupted traffic, traffic characteristics at unsignalised intersections, Capacity and LOS of signalized intersections.

References:

1. *Traffic Engineering and Transport Planning – L.R. Kadiyali, Khanna Publishers*

2. *Traffic Flow Theory and Control, Drew, D.R. McGraw Hill Book Co.*

CE-21390 Urban Mass Transit Systems L-3, T-1, P-0, Credits-4

Unit 1: Introduction to public transportation, evolution and role of urban public transportation modes, systems and services. Technological characteristics and their impacts on capacity, service quality, and cost, Mass Rapid Transit Systems (MRTS) in India.

Unit 2: Transit Data Collection and Performance Analysis: Current practice and new methods for data collection and analysis, Frequency and Headway Determination, Performance Monitoring

Unit 3: Vehicle Scheduling: Timetable Generation, vehicle and crew scheduling techniques

Unit 4: Economics and Financial Aspects: Effects of pricing policy and service quality on ridership, methods for estimating costs, organizational models for delivering public transportation service including finance and operations, Fare policy and technology,

Unit 5: Marketing and operations management.

Unit 6: Advance Public Transportation Systems: Technologies, Fleet Management Systems, Traveler Information Systems, Transport Demand Management.

References:

1. *A. Ceder, Public Transit Planning and Operation, Elsevier and BH.*

2. *K. A. Small and E. T. Verhoef, The Economics of Urban Transportation, Routledge.*

3. *M. E. Schmidt, Integrating Routing Decisions in Public Transportation Problems, Springer.*

4. *R. F. Casey et. al. , Advanced Public Transportation Systems: The State of the Art, Update 2000, Volpe National Transportation Systems Center, USA.*

5. *R. Iles, Public Transport in Developing Countries, Elsevier.*

6. *V. R. Vuchic, Urban Transit: Operations, Planning and Economics, Wiley.*

CE-22391 Advanced Airport Engineering L-3, T-1, P-0, Credits-4

Unit 1: Air transportation; Classification and size of airports; Aircraft characteristics; Air traffic control;
Unit 2: Airport location and necessary surveys; Planning, layout and design of runways, taxiways and aprons; Terminal service facilities - passenger, baggage and cargo handling systems; Lighting, visual aids, airport drainage.
Unit 3: Airport Cargo Facilities: Introduction, Functions and Design Factors of Terminals, Pallets, Containers, Apron Cargo Handling.
Unit 4: Operations and scheduling; Ground transportation facilities, Airport capacity and delays analysis
Unit 5: Airport Drainage and Pavement Design: Estimation of Runoff, Collection of Runoff, Subsurface Drainage, Flexible and Rigid Pavement Design.
Unit 6: Airport Access: Access Modes, Access Modal Choice Modal, Parking Space, Curb front Design, Capacity of Access Routes.

References:

1. *N.J. Ashford, S. Mumayiz, P. H. Wright, Airport Engineering: Planning, Design and Development of 21st Century Airports,John Wiley and Sons.*
2. *S. C. Rangwala and P. S. Rangwala, Airport Engineering,Charotar Publishing House Pvt. Limited.*
3. *R. Horonjeff, F. McKelvey, W. Sproule, Planning and Design of Airports,McGraw Hill Professional*
4. *S.K. Khanna, M.G. Arora and S.S. Jain, Airport Planing and Design, Nem Chand & Brothers.*

CE 22392 Advanced Highway Construction L-3, T-1, P-0, Credits-4

Unit 1: Various types of equipment for excavation, grading and compaction - their working principle, advantages and limitations. Special equipment for bituminous and cement concrete pavement, stabilised soil road construction.

Unit 2: Principles of gradation/proportioning of soil-aggregate mixes and compaction; Design factors, mix design, construction control and quality control, checks for mechanical, soil-cement, soil-bitumen and soil-lime stabilization methods. Use of additives, Numerical problems on mix design and application of Rothfutch method.

Unit 3: Preparation of Subgrade, Base and Sub bases, Construction of Water Bound Macadam (WBM), Wet Mix Macadam (WMM), Cement treated bases, Dry Lean Concrete (DLC), 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.

Unit 4: 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.

Unit 5: Highway Drainage: Design and construction of surface and sub-surface drainage system for highways. Drainage materials, design procedures and IRC Guidelines for Drainage of Urban Roads.

Unit 6: 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.

References:

1. MOST, Specifications for Road and Bridge Work (4th Revision), Ministry of Road Transport and Highways, 2001.
2. C. A. O' Flaherty, Highways – The Location, Design, Construction, & Maintenance of Pavements, Butterworth Heinemann, 2002.
3. R. N. Hunter, Bituminous Mixtures in Road Construction, Thomas Telford Services Ltd., 1995.
4. P. H. Wright, Highway Engineering, John Wiley & Sons, 1996.
5. S.K. Khanna and C.E.G. Justo, Highways Engineering, Nem Chand and Bros.

CE-22393 Highway Maintenance and Management Systems L-3, T-1, P-0, Credits-4

Unit 1: Components of pavement management systems, pavement maintenance measures.
Unit 2: Pavement performance evaluation: general concepts, serviceability, pavement distress survey systems, performance evaluation and data collection using different equipments. Non destructive Techniques.
Unit 3: Evaluation of pavement distress modelling and safety; pavement performance prediction: concepts, modelling techniques, structural conditions deterioration models, mechanistic and empirical models, HDM- IV models, comparison of different deterioration models, functional and structural conditions, deterioration models;
Unit 4: Ranking and optimization methodologies: recent developments, economic optimization of pavement maintenance and rehabilitation.
Unit 5: Project network management, Life cycle cost analysis.
Unit 6: Pavement Management Implementation and Expected Benefits.

References:

1. *Ralph Haas and Ronald W. Hudson, Pavement Management System, McGraw Hill Book Co.*
2. *A. M. Shiyab, Optimum Use of Pavement Condition Indicators in Pavement Management, VDM Verlag.*
3. *J. Yeaman, I.K. Lee (eds.), Handbook of Pavement Management: Principles and Practice of Management System Based on Visual Rating of Pavement Condition, Unisearch Limited SAMI Pty Ltd.*

CE-22394 Intelligent Transportation Systems L-3, T-1, P-0, Credits-4

Unit 1: Introduction; Core ITS services.
Unit 2: Enabling ITS technologies: Acquisition, communication and control
Unit 3: ITS Architectures and Business models.
Unit 4: ITS applications to sustainable mobility, safety, travel demand, Electronic toll collection.
Unit 5: ITS Cost and Benefits, Case Studies.
Unit 6: Emerging ITS Applications, Vehicle Infrastructure Integration.

References:

1. *Chen, Kan and John C. Miles, ed. ITS Handbook 2000: Recommendations from the World Road Association (PIARC). Artech House Inc, Boston, 1999.*
2. *McQueen, Bob, Rick Schuman, and Kan Chen. Advanced Traveler Information Systems, Artech House Inc., Boston, 2002.*
3. *Ozbay, Kaan, and Pushkin Kachroo. Incident Management in Intelligent Transportation Systems, Artech House, Boston.*

CE-22395 Sustainable Transportation L-3, T-1, P-0, Credits-4

Unit 1: Introduction, concepts and key parameters for sustainable transport. Transport policy.
Unit 2: Transport Planning- parameters, surveys, demand and supply analysis, Land Use and Transport planning.
Unit 3: Public Transport Planning and Transport Demand Management
Unit 4: Non Motorized Traffic and Urban mobility planning.
Unit 5: Transport and Environment; Transport Finances.
Unit 6: Urban transport projects- policies and case studies.

References:

1. *Ministry of Urban Development, Government of India (2006); National Urban Transport Policy.*
2. *UNEP (2013), NMT Infrastructure in India: Investment, Policy and Design.*
3. *TERI (2009), An exploration of sustainability in the provision of basic urban services in Indian cities.*

CE 22304 Design of Bridges L-3, T-1, P-0, Credits-4

Unit 1. Introduction/selection/Evolution of Bridge types, Loads and Forces.
Unit 2. Design of Culverts
Unit 3. Design of T-Beam Bridge.
Unit 4. Introduction to Design of different type Superstructures.
Unit 5. Introduction to Design of Abutments, Piers and Foundations.
Unit 6. Design of Bearings. Expansion joints.

References:

1. *Design of Concrete Bridges – Aswini, Vazrani & Ratwani*
2. *Design of Bridges- N. Krishna Raju*
3. *Design of Bridges- D. J. Victor*
4. *Concrete Bridges Design – V. K. Raina*
5. *Bridge Superstructure – N. Rajagopalan*
6. *IRC & IRS Codes*

CE-22358 Environmental Impact Assessment L-3, T-1, P-0, Credits-4

Unit 1: Overview of EIA; EIA at different levels: Regional; policy; sector levels, EIA process; Screening and scoping criteria.
Unit 2: Rapid and comprehensive EIA; Legal and Regulatory aspect in India; Environmental risk analysis; Economic valuation methods; Cost-benefit analysis; Expert system and GIS applications; Uncertainties.
Unit 3: Legislative and environmental clearance procedures in India and other countries, Siting criteria; CRZ; Public participation; Resettlement and rehabilitation Plans.
Unit 4: Practical applications of EIA; EIA methodologies; Baseline data collection; Prediction and assessment of impacts on physical; biological and socio-economic environment.
Unit 5: Environmental management plan; Post project monitoring, Environmental Audit, EIA report and EIS; Review process.
Unit 6: Case studies on EIA projects and Environmental Management Plan.

References

1. *Canter, L.W., " Environmental Impact Assessment ", McGraw Hill, New York, 1996.*
2. *Petts, J., " Handbook of Environmental Impact Assessment Vol. I and II ", Blackwell Science, London, 1999.*
3. *The World Bank Group., " Environmental Assessment Sourcebook Vol. I, II and III ", The World Bank, Washington, 1991.*

CE-22326 Finite Element Methods in Geotechnical Engineering
L-3, T-1, P-0, Credits-4

Unit 1: Introduction and Application of FEM in Geotechnical Engineering.
Unit 2: Energy concepts and variational principles, discretisation of continuous media. Two and three dimensional analysis.
Unit 3: Stiffness of simple elements, isoparametric elements and interface elements, assembly and solution techniques, computerization.
Unit 4: Introduction to nonlinear problems, plasticity problems and no tension analysis. Applications to such as stress distribution and deformations in isotropic and anisotropic soil and rock media.
Unit 5: Stress and deformations around excavations and built-up embankments, seepage through porous media, one dimensional consolidation, stress distribution around openings in intact and fissured rock.
Unit 6: Finite element Problem- slope stability analysis, soil-structure interaction, seepage analysis, underground excavations, foundations, earth dam etc. Overview of Finite Element Software's: ANSYS, Geo-5, NISA etc.

References

1. *Introduction to the finite element method by C.S. Desai and J.F. Abel., CBS Publishers.*
2. *Finite element analysis, Theory and Programming" by C S Krishnamoorthy. Pub. Tata McGraw-Hill.*
3. *Finite element procedures in engineering analysis, K.J. Bathe., pub. Prentice Hall*

GI-22303 LiDAR Technology **L-3, T-1, P-0, Credits-4**

Unit 1: Altimetric LiDAR: Physics of laser, spectral characteristics of laser, laser interaction with objects; Airborne Altimetric LiDAR: principle, topographic and bathymetric LiDAR, multiple returns, full wave digitization; Overview of mobile LiDAR.
Unit 2: Components of a LiDAR system: INS technology, INS-GPS integration, measurement of laser range, calibration.
Unit 3: LiDAR geolocation models; Accuracy of various components of LiDAR and error propagation, error analysis of data and error removal.
Unit 4: LiDAR data visualization; Data classification techniques, raw data to bald earth DEM processing, uses of return intensity and full waveform in information extraction, LiDAR data integration with spectral data. LiDAR applications: building and tree detection, power line extraction.
Unit 5: Mobile LiDAR: Components and their integration; processing of mobile LiDAR data for road way inventorization, infrastructure and asset management.

References

1. *Vosselman, G., Maas, H. G., Airborne and Terrestrial Laser Scanning, Whittles Publishing, 2010.*
2. *Shan, J., Toth, C. K., (Eds.), Topographic Laser Ranging and Scanning: Principles and Processing, CRC Press, 2008.*
3. *Measures, R.M., Laser Remote Sensing: Fundamentals and Applications, Krieger Publishing Company, 1992.*
4. *Fujii, T., Fukuchi, T., (Eds.), Laser Remote Sensing, CRC Press, 2005*

CE-22301 Optimization Methods in Civil Engineering

L-3, T-1, P-0, Credits-4

Unit 1: Introduction: Historical development, Engineering applications of optimization, statement of an optimization problem, classical optimization techniques.
Unit 2: Linear Programming: Simplex method and Revised simplex method for linear programming problems. Application of linear programming to civil engineering problems.
Unit 3: Non-Linear Programming: Optimization of one dimensional variable problems by various methods.
Unit 4: Unconstrained and constrained optimization problems of non linear programming methods.
Unit 5: Genetic algorithm and ANN and their applications.

References:

1. *Fox, R.L., Optimization Methods for Engineering Design.*
2. *Rao, S.S., Optimization Techniques, Theory and applications.*
3. *Copper, L. and Cooper M.W., Introduction to Dynamic Programming*
4. *Fiacco, A.V., McCormic, G.P., Non-Linear programming: Sequential Unconstrained Minimization Techniques.*
5. *Duffin, Peterson and Zenar, Geometric Programming.*
6. *Wilde, J.D., and Beightler, C.L., Foundation of Optimization.*
7. *Taha H., An introduction to OR.*

MA-22303: Statistical and Probabilistic Analysis L-3, T-1, P-0, Credits-4

Unit 1: Introduction and Basic Concepts: Role of Statistics in Engineering, Graphical Methods for Displaying Data: Histogram, Box and Whisker Plot, Quantile Plot, Scatter Plot, Time Series Plot.

Unit 2: Numerical Summary Measures: Measures of Central Tendency- Mean, Median, Trimmed Mean and Proportion, Measures of Relative Standing: Percentile, Quartile, Measure of Variability: Range, Variance, Standard Deviation, Coefficient of Variation, Measure of Association: Pearson Sample Correlation Coefficient, Spearman Correlation Coefficient.

Unit 3: Probability and Random Variables: Introduction, Sample Spaces and Events, Interpretation of Probability, Random Variables, Covariance and Correlation of Random Variables, Computing Expected values of functions of random variables, Conditional Probability, Bayes Theorem.

Unit 4: Probability and Sampling Distributions: Introduction, Discrete Distributions: Binomial, Poisson distribution and Negative Binomial, Continuous: Normal, *t*-Distribution, Lognormal, Exponential, Gamma, Chi-Square, *F*-Distribution, Beta. Random Sampling, Sampling Distribution of Sampling Mean, Sample Variance and Sample Proportion.

Unit 5: Hypothesis Testing and Interval Estimation: Introduction, Inferences on a single population mean: *z*-Test, *t*-Test, bias-adjusted confidence intervals. Chi-Square Goodness of fit test. Inferences about two population means: Paired *t*-Test, pooled *t*-Test, unequal variance *t*-Test, Interval Estimates, Inferences about one population and two population variances, ANOVA and distribution-free tests,

Unit 6: Regression Analysis and Cross Validation: Simple linear regression, Least squares estimation, Tests for slope and correlation, Prediction problem, Graphical residual analysis, Q-Q plot to test for normality of residuals, Poisson Regression Model, Negative Binomial Regression Model, Cross Validation Methods.

References:

1. *D. C. Montgomery, Applied Statistics and Probability for Engineers, Wiley.*
2. *S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons.*
3. *Clifford Spiegelman, E.S. Park and, L. R. Rilett, Transportation Statistics and Microsimulation, CRC Press.*