DEPARTMENT OF CIVIL ENGINEERING

COURSE STRUCTURE & SYLLABUS

M .Tech Transportation Engineering (Course Code:22) Programme

R25 Draft

I YEAR I – SEMESTER

S. No	Course Codes	Course Title	L	T	P	C
1	M252201	Advanced Highway Engineering	3	1	0	4
2	M252202	Advanced Traffic Engineering	3	1	0	4
3	M252203	Ground Improvement Technique	3	1	0	4
4		Professional Elective - I	3	1	0	4
	M252204	a) Bridge Engineering				
	M252205	b) Project Management				
	M252206	c)Artificial Intelligence and Machine Learning in Transportation				
	M252207	d) Pavement Drainage System				
5		Professional Elective - II	3	1	0	4
	M252208	a) GIS for Transportation				
	M252209	b) Pavement Management System				
	M252210	c) Transportation Modeling and Simulation				
	M252211	d) Sustainable Transportation				
6	M252212	Computational Transportation Eng. Lab	0	0	3	2
7	M252213	Highway Aggregate and Bituminous Testing Lab	0	0	3	2
8	M252214	Seminar-I	0	0	2	1
		Total	**15**	**5**	**8**	**25**

I YEAR II – SEMESTER

S. No.		Course Name	L	T	P	C
1	N252201	Pavement Analysis and Design	3	1	0	4
2	N252202	Transportation Planning	3	1	0	4
3	N252203	Traffic Analysis and Design	3	1	0	4
4		Professional Elective - III				
	N252204	a) Pavement Construction	3	1	0	4
	N252205	b) Environmental Impact Assessment				
	N252206	c)Traffic Flow Analysis				
	N252207	d) Pavement Evaluation and Rehabilitation				
5		Professional Elective - IV				
	N252208	a) Geo synthetics and Reinforced Earth Structures	3	1	0	4
	N252209	b) Highway Safety Engineering				
	N252210	c) Intelligent Transportation System				
	N252211	d) Public Transportation Systems				
6	N252212	Advanced Transportation Engineering Lab	0	0	3	2
7	N252213	Transportation Simulation Lab	0	0	3	2
8	N252214	Seminar-II	0	0	2	1
		Total	**15**	**5**	**8**	**25**

II YEAR I – SEMESTER

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	O252201	Research Methodology and IPR Swayam (12 weeks) MOOC course-RM&IPR	3	0	0	3
2.	O252202	Summer Internship/ Industrial training (8-10 weeks)*	0	0	0	3
3.	O252203	Comprehensive viva#	0	0	0	2
4.	O252204	Dissertation Part-A$	0	0	16	8
		Total	**3**	**0**	**20**	**16**

Student attended during summer/ year break and assessment will be done in 3rd Semester.
 # Comprehensive viva can be conducted courses completed upto 2nd Semester.
$ Dissertation -Part A, Internal assessment.

II YEAR II - SEMESTER

S.No	Course Code	Course Title	L	T	P	Credits
1.	P252201	Dissertation Part-B%	0	0	28	14
		Total	**0**	**0**	**28**	**14**

% External Assessment

I Year-I Semester		L	T	P	C
		3	0	0	3
	Advanced Highway Engineering				

UNIT–I

Geometric Design of Highways: Functional classification of Highway system; Design controls - Topography, Driver characteristics, Vehicle characteristics. Traffic ,Capacity and Level of Service, Design speed .Objectives of Geometric Design. Road Margins - design specifications; Pavement surface characteristics - Skid Resistance, measurement of skid resistance; Road roughness, measurement of Road roughness; Camber design and standards.

UNIT-II

Horizontal and Vertical Alignment: Sight Distance - SSD, OSD and ISD. Horizontal curves, Superelevation; computing of super elevation; attainment of super elevation; Extra widening on curves; Transition curves - Objectives and Design. Gradients - Types of Gradients, Design Standards; Summit Curves, Valley curves and Design criteria. Combination of Vertical and Horizontal curves - Grade Compensation.Importance of Sight Distances for Horizontal and Vertical curves.

UNIT-III

Design of Intersections: Types of Intersections; Design Principles for Intersections; Design At gradIntersection-Channelization,Objectives;-Traffic Islands and Design standards Rotary Intersection Concept, Advantages and Disadvantages; Gradeseparated Interchanges-Types, warrants and Design standards as per IRC.

UNIT-IV

Traffic Signs and Road Markings: Types of Road Signs; Guidelines for the provision of Road Signs;Caution Signs, Regulatory signs. Information signs - Design standards. Road markings - Objectives of Road markings; Types of Road Marking, Role of Road markings in Road Safety and Traffic Regulation; Specification for Road Marking Highway Appurtenances-Delineators, Traffic Impact Attenuators, Safety Barriers.

UNIT–V

Pedestrian Elements: Requirements of Pedestrians; Pedestrian facilities on Urban Roads; Cycle Tracks - Guidelines and Design standards; Bus bays-Types and Guide lines-Design of On street and Off street parking facilities - Guidelines for lay out Design. Design of Subways and foot over bridges.

I Year-I Semester		L	T	P	C
		3	0	0	3
	Advanced Traffic Engineering				

UNIT-I

Basic Aspects of Traffic Engineering Aim of traffic engineering, traffic stream components and characteristics, road user characteristics, vehicle characteristics, acceleration characteristics, measures of quality, measures of separation, relationship among traffic parameters and empirical relationships, mechanics of traffic flow, macroscopic approach, microscopic-approach and human factors approach, discrete distributions, binomial distribution, Poisson's distribution, exponential distribution, exponential distribution, normal distribution.

UNIT-II

Traffic Studies, Measurement and Analysis; Volume studies, speed studies, travel forecasting principles and techniques, design hourly volumes and speed, origin and destination studies, presentation of data and analysis, testing of hypothesis relating to improvements.

UNIT-III

Travel Time amid Delay Studies; Various uses, travel time and delay studies, various methods, data collection and analysis, density studies and headways, gap acceptance studies, intersection delay studies,traffic flow theory, queuing theory and simulation models.

UNIT-IV

Capacity Analysis of Traffic Facilities; Uninterrupted facilities, interrupted facilities, Level of Service, quality of service as per HCM, factors affecting LOS, computation of capacity and LOS, Measure of effectiveness, highway capacity and performance characteristics, intersection design.

UNIT-V

Traffic Control, Design and Regulation; Traffic signals, types, principles of phasing, tune diagram, signalized intersection, saturation flow, saturation headway, capacity of lane group, concept of critical lane group, signal timing, phase plan, phase diagram, splitting of phase, clearance interval, pedestrian requirement, guidelines for protected movements, signal co-ordination, emerging themes, inter-modalism, access management, congestion management, environmental impact assessment.

Suggested Reading

1. IntroductiontoTrafficEngineering,R.SrinivasaKumar,UniversitiesPress,2018.
2. Highway Capacity Manual, Transportation Research Board, National Research Council,Washington, D.C., 2010.
3. Daganzo, C.R, Fundamentals of Transportation and Traffic Operations, Pergamon, Elsevier Science Inc., New York, 1997.
4. Salter,R.J.,Traffic Engineering: Worked Examples,Macmillan,London,1989.

5. Pignataro,L.J.,Traffic Engineering: Theory and Practice,Prentice Hall,Englewoodlifts,1973.
6. Wohl, M.and Martin, B.V, Traffic System Analysis for Engineer sand Planners ,McGraw Hill, New York, 1983.
7. Drew, D.R., Traffic Flow Theory, McGraw Hill,NewYork,1964.

I Year-I Semester		L	T	P	C
		3	0	0	3
Ground Improvement Technique					

UNIT-I

Introduction – Need for Engineering Ground – Classifications of Ground Modification Techniques – Suitability, Feasibility and Desirability. Densification of cohesionless soils – deep Compaction – Vibroflobation – Vibro Composer method Blasting – Densification at Ground. - Vibrocompaction - Heavy Tamping, Stability of foundation trenches and surrounding structures through soil Nailing.

UNIT-II

Stabilisation- Mechanical Stabilisation, Lime Stabilisation,Cement Stabilisation ,Bitumen Stabilisation, Thermal Stabilisation and Chemical Stabilisation.

UNIT:-III

Dewatering and Grouting: - Dewatering methods – open sumps and ditches – gravity flow wells – Vacuum dewatering – Electro – kinetic dewatering – electrosmosis - Overview of grouting - Suspension grouts – Solution grouts –Methods of grouting – Grouting applications– Dams, Tunnels, Shafts and drifts,excavations.

UNIT-IV

Improvement of Cohesive soils –Preloading Soil Replacement –Radial Consolidation–Vertical and Radial Consolidation - Vertical Drains – Sand Drains – Effect of Smear – Sand wicks – Band drains – Dynamic Compaction.

UNIT-V

Stone Columns – Methods of installation of Stone Columns – Load shared by stone columns and the stabilized ground – uses of stone columns Lime columns and granular trenches – Installation – Improvements expected on Soil behavior. In situ ground reinforcement– ground anchors – types – Components and applications –uplift capability.

REFERENCE:

1. Construction and Geotechnical Methods in Foundation Engineering By R.M. Koerner, McGraw – Hill Book Co.

2. Current Practices in Geotechnical Engineering Vol.1,AlamSingh and Joshi,International

Book Traders, Delhi, & Geo-Environ Academia.

3. Foundation Analysis and Design (1VEd.)By J.E. Bowles ,McGraw –Hill Book Co.,

4. Ground Improvement Techniques by P.Purushotham Raj, Laxmi Publications (P) Ltd., New Delhi.

5. Ground Improvement–Edited by M.P.Moseley, Blackie Academic & Professional.

6. Soil Mechanics for Road Engineers, H.M.S.O, Londan.

7. Ground Improvement Techniques by Bergado et al.

I Year-I Semester		L	T	P	C
		3	0	0	3
Bridge Engineering					

UNIT-I

Masonry arch Bridge design details- Rise, radius, and thickness of arch- Arch ring- Dimensioning of sub structures- Abutments pier and end connections.(Ref: IRC- SP-13)

UNIT-II

Super Structure: Slab bridge- Wheel load on slab- effective width method- slabs supported on two edges- cantilever slabs- dispersion length- Design of interior panel of slab- Pigeaud's method-design of longitudinal girders- Guyon- Mess on et method- Hendry Jaegar method-Courbon's theory. (Ref: IRC-21), voided slabs, T- Beam bridges.

UNIT-III

Plate girder bridges- Elements of plate girder and their design-web-flange- intermediate stiffener-vertical stiffeners- bearing stiffener-design problem

UNIT-IV

Composite bridges- Composite action- shear connectors- composite or transformed section- design problem.(Ref: IRC: Section-VI)

UNIT-V

Sub structure- Abutments- Stability analysis of abutments- piers- loads on piers – Analysis of piers- Design problem(Ref: IRC-13, IRC-21, IRC-78)- Pipe culvert- Flow pattern in pipe culvers- culvert alignment- culvert entrance structure-Hydraulic design and structural design of pipe culverts-reinforcements in pipes .(Ref: IRC: SP-13)

REFERENCES:

1. Design of concrete bridges-Aswini,Vazirani, Ratwani
2. Essentials of bridge engineering-Johnson Victor D Design of bridges- Krishna Raju

I Year-I Semester		L	T	P	C
		3	0	0	3
	Project Management				

UNIT-I

Introduction to Project Management: A systems Approach, Systems Theory and Concepts, Organisation, Management Functions, Overview of Management Objectives, Tools and Techniques, Project Management – Processes and Organisational Structures – Team Management – Project Manager as a Team Leader – Leadership Qualities, PMIS.

UNIT-II

Construction Cost and Value Engineering: Types of Estimates, Implementation of Cost Controls, Project Cost Forecasting, Cost Optimisation and Resources Planning - Value Engineering, Techniques for Project Selection, Break-Even Analysis, Cost Modelling, Energy Modelling, Life Cycle Cost Approach.

UNIT-III

Contract Management Safety in Construction Industry : Tendering and Contracting, Laws of Contracts, subcontracts, Potential Problems, Post Contract Problems, Documents, Conditions, Arbitration, Special Features of International Contracts. Quality Management and Safety in Construction Industry –Quality control by statistical methods, sampling plan, control charts, ISO 14000, Safety Measures, Safety Programmes, Safety Awareness and Implementation of Safety Plan – Compensation.

UNIT-IV

Project Scheduling and Analysis Methods: CPM, PERT, Linear programming, queuing concept, simulation, bidding models, game theory.

UNIT-V

Human Resource Management and Construction Management Practices : Man Power Planning –Training – Motivation – Industrial Relations – Welfare Measures – MIS – Components and Structure – Personal Management. Resource Management and Inventory - Basic concepts, labour requirements & productivity, non-productive activities, site productivity, equipment and material management, inventory control. Construction Management Practices - Implementation of Procedures and Practices – International Experiences– Case Studies – Examples.

REFERENCES:

1. Herold Kerzner - Project Management - A systems approach to Planning, Scheduling and Controlling. CBS Publishers and Distributors.

2. K.Waker A Teraih and Jose M.Grevarn; Fundamentals of Construction Management and Organisations.

3. AnghelPatterson-ConstructionCostEngineeringHandbook-MarcelDekkenInc.

4. DellIsola-Value Engineering in Construction Industry,Van Nostr and Reinhold Co.,

5. Choudhary,S. Project Management, Tata McGraw Hill Publishing Co., Ltd.,

6. Raina UK, Construction management Practices, Tata McGraw hill Publishing Company Ltd.

7. Sengupta B and Guha H, Construction Management and Planning, Tata McGraw-Hill Publishing Company Limited, New Delhi.

I Year-I Semester		L	T	P	C
		3	0	0	3
Artificial Intelligence and Machine Learning in Transportation					

Artificial Intelligence (AI) Background: Introduction, History, and Evolution Agents of Artificial Intelligence, Introduction to Fuzzy System (FS), Artificial Neural Network (ANN), Evolutionary Computing (EC), Genetic Algorithm (GA), Particle Swarm Algorithm (PSO).

Machine Learning Background: Introduction, Historical context, Machine Learning: Unsupervised Learning, Supervised Learning, Semi-supervised Learning, Reinforcement Learning, Recapitulation of linear regression, logistic regression, Necessities, ML in Transportation engineering, and Real-world application examples.

Shallow Supervised Algorithms: Nearest Neighbor, Neural Networks Learning, Back propagation, Support Vector Machines, Applications to traffic engineering, road crash classification, K Nearest Neighbor (KNN), ANN, Fuzzy Rule-Based, and other Classifiers.

Convolutional Neural Networks: Introduction to Conv Nets, activation functions, hyper-parameter tuning, dropout, batch normalization. Applications to camera-based classification and object detection related to driver behaviour, vehicle detection, pavement distress detection, Deep Learning and Transfer Learning: Deep Neural Networks (DNN), Fuzzy Neural Networks (FNN), etc.

Unsupervised Clustering: Hierarchical clustering, K-means clustering, Density-based clustering. Applications on transportation mode inference, level of service of roads. Fuzzy c-means (FCM), Self- organizing maps (SOM), and other Clustering Algorithms

Recurrent Neural Networks: Recurrent Neural Networks, Long-Short Term Memory. Applications to traffic state (speed, volume) prediction, traffic crash prediction, traffic flow modeling, etc.

Learning Resources:

Textbooks:
1. Trevor Hastie, Robert Tibshirani, Jerome Friedman; The Elements of Statistical Learning: Data Mining, Inference and Prediction, Springer, 2009, Second Edition.
2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2016.
3. Ian Good fellow, Yoshua Benjio, and Aaron Courville, Deep Learning, The MIT Press, 2016.

Reference :

1. Manaranjan Pradhan, U Dinesh Kumar; Machine Learning using Python, Wiley, 2020.
2. Paresh Chandra Deka, A Primer on Machine Learning Applications in Civil Engineering, CRC Press, 2019, First Edition.
3. Stuart J. Russell and Peter Norvig; Artificial intelligence: A Modern Approach, Prentice Hall, 2022, Fourth Edition.

Online Resources

1. https://onlinecourses.nptel.ac.in/noc22_cs56/preview
2. https://nptel.ac.in/domains/discipline/106?course=106_0

I Year-I Semester		L	T	P	C
		3	0	0	3
Pavement Drainage System					

UNIT-I

Pavement Drainage Structures: Pavement types, relevant pavement materials, source and role of water, factors affecting the flow of water, hydraulic conductivity, estimation of surface runoff, typical drainage in pavements, detention and retention ponds, estimation of discharge of detention and retention of ponds, and impact of water on pavement distresses.

UNIT-II

Cross Drainage Works: The necessity of culverts, planning of culverts and effective drainage, types and size of culverts, ditches, side drains design considerations, common culverts problems and solutions, disposal of drainage water and maintenance of drainage system, storm water harvesting methods, and benefits of groundwater recharge.

UNIT:-III

Surface Drainage: General, the effect of standing water on pavement performance, factors affecting the surface drainage, geometric features of pavement, maintenance of side drains, medians, culverts, the hydrological requirement of roadside drains, factors affecting runoff, and design methodologies.

UNIT-IV

Subsurface Drainage: Permeable bases stabilised and unstabilised bases, aggregate layers, geotextiles separate layers ,longitudinal drains, filter design, geo composite design, and capillary barrier drain ,determination of pavement permeability, and framework for drainage system sunder new concrete pavements.

UNIT-V

Sustainable Drainage: Porous asphalt pavement design, construction, and maintenance; design of porous concrete; design of permeable interlocking concrete pavements, construction, and maintenance; sustainable urban drainage systems; and applicability of

specific SUDS structures.

Textbooks:

1. E.J. Yoder, M.W. Witczak ; Principles of Pavement Design, Wiley India Pvt. Ltd., New Delhi, India, 2011, Second Edition.
2. Phil Pitman, External Works, Roads, and Drainage: A Practical Guide, CRC Press, 2017, First Edition.
3. Sivakumar Babu G.L., Prithvi S. Kandhal; Pavement Drainage: Theory and Practice, CRC Press, New Delhi, India, 2019.

Reference:

1. Caleb N. Arika, Dario J. Canelon, John L. Nieber, Subsurface Drainage Manual for Pavements in Minnesota, LRRB, Minnesota Department of Transportation, 2009.
2. J. Paul Guyer, An Introduction to the Principles of Pavement Drainage, Independently Published, 2013.
3. S.N. Sachdeva, Design of Road Drainage System: A Design Reference Book, Create Space Independent Publishing Platform, 2018.
4. W Hudson, Ralph Haas, Waheed Uddin; Infrastructure Management: Integrating Design, Construction, Maintenance, Rehabilitation, and Renovation, McGraw Hill Education, 1997.
5. AASHTO Drainage Manual, American Association of State Highway Officials, 2014.
6. AASHTO Highway Drainage Guide, American Association of State Highway and Transportation Officials, Washington DC, 2007, 4th Edition.
7. IRC: SP20-2013,Guidelines on Urban Drainage, Indian Roads Congress, New Delhi, 2013.

Online Resources:

1. https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4986
2. https://freevideolectures.com/course/3352/geosynthetics-engineering-in-theory-andpractice/21
https://www.youtube.com/watch?v=YQDR6fro8mM

I Year-I Semester		L	T	P	C
		3	0	0	3
	GIS for Transportation				

UNIT-I

Introduction to GIS: Introduction, GIS over view, use of GIS in decision making, Data processing, Components of GIS, The GIS and the organization.

UNIT-II

Data Input and Output: Data input - Key board entry, Remotely and sensed data, existing digital data, census related data sets, Data output - Hard copy and soft, copy devices.

UNIT-III

Data Quality and Data Management: Components of data quality - Micro level, Macro level components, Sources of error, A note about data accuracy. The data base approach, 3 classic data models, Nature of geographic data, Spatial data models, Databases for GIS.

UNIT-IV

GIS Analysis, Functions and Implementation: Organizing geographic data for analysis, Maintenance and analysis of the spatial data and non-spatial attribute data and its integration output formatting. Awareness, Developing system requirements, Evaluation of alternative systems, System justification and Development of an implementation plan, System acquisition and start up, Operation of the system.

UNIT-V

Application of GIS in Transportation Engineering : Intelligent information system for road accessibility study, GIS data base design for physical facility planning, Decision support systems for land use planning. GIS applications in environment impact assessment, GIS based Highway alignment, GIS based road network planning, GIS based traffic congestion analysis and accident investigation.

REFERENCES:

GISA Management, PerspenfiStan Aronoff, WDL Publisher.

I Year-I Semester		L	T	P	C
		3	0	0	3
	Pavement Management System				

UNIT-I

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

UNIT-II

Pavement Performance: Serviceability Concepts- roughness-Roughness Components- Equipment-IRI - modeling techniques, structural condition deterioration models, mechanistic and empirical models, HDM and other models, comparison of different deterioration models.

UNIT-III

Pavement Evaluation:

Functional Evaluation: Functional and Structural deterioration models, unevenness prediction models and other models, comparison. Case studies. Equipments Structural Evaluation:-Basics-NDT and Analysis—Condition Surveys-Distress-Destructive Structural Analysis- Application in Network and Project Levels

UNIT-IV

Design Alternatives, Rehabilitation and Maintenance: Design objectives and constraints, basic structural response models, physical design inputs, alternate pavement design strategies and economic evaluation, life cycle costing, analysis of alternate pavement strategies based on distress and performance, case studies. Equipments. Identification of Alternatives-Deterioration Modeling- Priority Programming Methods.

UNIT-V

Expert Systems and Pavement Management: Role of computers in pavement management, applications of expert systems for managing pavements, expert system for pavement evaluation and rehabilitation, knowledge-based expert systems, case studies.

TEXTBOOKS:

1. Ralph Haas and Ronald W. Hudson, Pavement Management System', McGraw Hill Book Co.1978

2. Ralph Haas, Ronald Hudson Zanieswki. Modern Pavement Management, Kreiger Publications.

3. Proceedings of North American Conference on Managing Pavement.

4. ProceedingsofInternationalConferenceonStructuralDesignofAsphaltPavementsNCHRP,TRRandTRB Special Reports

I Year-I Semester		L	T	P	C
		3	0	0	3
	Transportation Modelling and Simulation				

UNIT-I

Introduction of Modeling: Fundamentals of systemic approach. System modeling, Model structure, Variables, controllable variables, uncontrollable variables, parameters, coefficients and other statistical methods for testing of models and data.

UNIT-II

Classification of Models; Classification of models - Linear models, Non-linear models, Time-invariant models, Time-variant models, State-space models, Distributed. parameter models. System Synthesis- - Direct and Inverse Problems, Role of optimization and Examples from transportation engineering.

UNIT-III

Preliminary Data Processing: data collection, Regression Analysis-Linear multiple regression analysis; Analysis of residues, Tests of goodness of fit. Spatial Distribution- Polynomial surfaces, Spline functions, Cluster. analysis and Numerical production of contour maps. Time Series Analysis-Auto-cross. correlation analysis, Identification of trend, spectral analysis, Identification of dominant cycles, smoothening techniques, Filters and forecasting.

UNIT-IV

Model Building: Choice of Model Structure- A priori considerations, Selection based upon preliminary data analysis, Comparing model structures. Model Calibration- Role of historical data, Direct and Indirect methods of solving inverse problem.-Model Validation.

UNIT-V

Simulation; Random variables, Basic concepts. Probability density and distribution functions, Expectation and standard deviation of discrete and continuous random variables and their functions, Covariance and correlation, commonly used theoretical Probability distributions: Uniform, Normal, Binomial, Poisson, Negative exponential. Fitting distributions to raw data: Chi-square and Kolmogrov-Smirnov's tests of the goodness off it. Central limit theorem, various algorithms for generation of Random numbers. Queuing theory: Elements, Deterministic queues. Applications of Monte, Carlo simulation:" Basic concepts. Generation-of synthetic observations, - Statistical interpretation of the output, Evaluation of definite integrals and examples.

References

1. Bratley ,P. Fox B.L., Schrage, L.E.B. Guideto Simulation, Springer-Verlag, New York 1983.
2. Leigh, J.R., Modeling and Simulation, Peter Peregrinus, London, 1983.
3. Bernard, Z., Theory of Modeling and Simulation, John-Wiley, New York, 1976.
4. Ortuzar ,J. and Willumsen ,L.G, Modeling Transport, Wiley, Chinchestor, 1994.
5. Hansher D.A ,and Button.K.J ,Handbook of Transport Modeling, Pergamon, Oxford, UK, 2000

I Year-I Semester		L	T	P	C
		3	0	0	3
	Sustainable Transportation				

UNIT - I

Problem of Sustainability in Transport: Energy use in the transport sector; Transport and climate change; Greenhouse gas emissions, urban air quality, Congestion, and sustainability, Sustainable Development Goals; Sustainable transport concepts – society, environment and economy, indicators based approach Policy initiatives and programs on sustainable transport - global perspectives (SUMP, KYOTO Protocol);national policies (NUTP, CMP and NAPCC) and local initiatives; Transport system effectiveness and efficiency – service level benchmarks

UNIT - II

Planning for Sustainability: Urban form, Indicator based planning, Land-use plans, zoning schemes and provisions, Integrated land use and transport planning and neighbourhood designs, Compact City, Public Transit, TOD, NMT, First and Last Mile Connectivity; Integrated multi-modal transport networks, Regulations and Enforcements (Parking policy, Congestion pricing).

UNIT - III

Evaluation of Non Motorized Transportation: Surveys, Dem and Estimation, and Analysis; Crash Data, Barrier Effect; Cycling Condition Evaluation Techniques; Pedestrian Condition Evaluation Techniques; Prioritizing Improvements and Selecting Preferred Options.

UNIT - IV

Planning for Pedestrians: Types of pedestrians and Characteristics; Pedestrian facilities and planning; Pedestrian standards and improvements; Pedestrian Facility Design, LOS; Pedestrian safety programs.

Planning for Bicyclists: Types of cyclists and Bikeways; Integrating cycling into roadway planning; Bicycle network planning; Accommodating cyclists on rural roads; Design of Bicycle boulevards/bike paths; Bicycle Parking/storage Facilities; Roadway maintenance for cyclists.

UNIT - IV

Sustainable Policies: Continuum of Policies, speed and speed limit policies, national policies, sustainable travel demand management, public awareness, pricing transportation, total cost of transportation, pricing, and taxation.

Sustainable Technology: Telecommuting, Information and Communication Technologies, E-commerce, Alternative Cleaner Fuels, vehicle technologies, fuel cells, and Intelligent Transport Systems.

Learning Resources:

Text Books:

1. Henrik Gudmundss on, Ralph P.Hall, Greg Marsden, Josias Zietsman, Sustainable Transportation: Indicators, Framework, and Performance Management, Springer, 2016.
2. Preston L. Schiller, Jeffrey R. Kenworthy, An Introduction to Sustainable Transportation: Policy, Planning and Implementation, Routledge, 2017, Second Edition.
3. William R. Black, Sustainable Transport: Problems and Solutions, Guilford Press, New York, 2010.

Reference:

1. Carey Curtis (Ed), Handbook of Sustainable Transport, Edward Elgar, 2020.
2. Mehrdad Ehsani, Fei-Yue Wang and Gary L. Brosch (Eds.), Transportation Technologies for Sustainability, Springer-Verlag, New York, 2013.
3. Robert Cervero, Accessible Cities and Regions: A Framework for Sustainable Transport and Urbanism in the 21st Century, Center for Future Urban Transport, Institute of Transportation Studies, University of California, Berkeley, 2005.
4. Rodney Tolley (Editor), Sustainable Transport: Planning for Walking and Cycling in Urban Environments, CRC Press, 2003.

Online Resources

1. https://onlinecourses.nptel.ac.in/noc21_ce74/preview
2. https://www.cutr.usf.edu/workforce/education/sustainable-transportation-course/

I Year-I Semester		L	T	P	C
		3	0	0	3
Computational Transportation Engineering Lab					

1. Programming using Python language
2. Data Structures.
3. Applications in Transportation Engineering

I Year-I Semester		L	T	P	C
		3	0	0	3
Highway Aggregate and Bituminous Testing Lab					

1. Bitumen and Tar Tests as per IS code provisions.
2. Benkelman beam test
3. Stone Polishing Value test
4. International Roughness Index test
5. Mix design for Bituminous mixes
6. Falling Weight Deflect meter.
7. Aggregate tests.
8. Tests on sub grade soils.
9. Soil stabilization tests.
10. California Bearing Ratio Test
11. Soil Classification & Grain size analysis.
12. Mini project based on field and laboratory studie sand data collected.
13. Mini project based on field and laboratory studie sand data collected.

Note: All tests as per IS, ASTM, AASHTO, TRL, IRC procedures / specification sand guidelines

I Year-II Semester		L	T	P	C
		3	0	0	3
	Pavement Analysis and Design				

UNIT-I

Pavement Types, Wheel Loads and Design Factors

Definition of Pavement Types, Comparison of Highway pavements, Wheel Loads, Tyre pressure, Contact pressure, Design Factors: Traffic and Loading, Environment, Materials, Failure criteria, Reliability.

UNIT-II

Stresses in Pavements

Layered System Concepts: One Layer System: Boussinesq Theory. Two Layer Theory: Burmister's Theory. Three Layer System. Stresses in Rigid Pavements. Relative Stiffness of Slabs, Modulus of Subgrade Reaction, Stresses due to Warping, Stresses due to Friction, Stresses due to Load, IRC Recommendations.

UNIT-III

Pavement Design

IRC Method of Flexible Pavement Design, AASHTO Method of Flexible Pavement Design, IRC Method for Rigid Pavements, use of Geosynthatics in pavements.

UNIT-IV

Pavement Inventories

Serviceability Concepts, Visual Rating, Pavement Serviceability Index, Roughness Measurements, Measurement of Distress Modes Cracking, Rutting, Rebound Deflection using Benkleman Beam Deflection Method, Load Man Concept, Skid Resistance Measurement.

UNIT-V

Pavement Evaluation

Functional Pavement PerformanceEvaluation: AASHTO Method, Psycho Physical and Psycho Metric Scaling Techniques, Deduct Value Method Beam Deflection Method, Pavement Distress Rating Technique. Design of Overlays by Benkelmen Beam Deflection Methods as per IRC – 81 - 1997 – pavements on problematic soils.

REFERENCES:

1. Yoder and Witzorack,―Principles of Pavement Design‖, John Willey and Sons.
2. Yang, H. Huang, ―Pavement Analysis and Design‖, Prentice Hall Publication, Englewood Cliffs, New Jersy.
3. Sargious, M.A. Pavements   and Surfacings for Highway
   sand Airports – Applied science Publishers limited

4. RalpsHass and Hudson,W.R.—Pavement Management System Mc-GrawHill Book Company. IRC codes of practice.

I Year-II Semester		L	T	P	C
		3	0	0	3
	Transportation Planning				

UNIT-I

Urban Transportation Problem Travel Demand: Urban Issues, Travel Characteristics, Evolution of Planning Process, Supply and Demand– Systems approach. Travel Demand: Trends, Overall Planning process, Long term Vs Short term planning, Demand Function, Independent Variables, Travel Attributes, Assumptions in Demand Estimation, Sequential, and Simultaneous Approaches, Aggregate and Disaggregate Techniques.

UNIT-II

Data Collection And Inventories: Collection of data – Organisation of surveys and Analysis, Study Area, Zoning, Types and Sources of Data, Road Side Interviews, Home Interview Surveys, Commercial Vehicle Surveys, Sampling Techniques, Expansion Factors, Accuracy Checks, Use of Secondary Sources, Economic data – Income – Population – Employment – Vehicle Owner Ship.

UNIT-III

Four Stage Demand Forecasting : UTPS Approach, Trip Generation Analysis: Zonal Models, Category Analysis, Household Models, Trip Attraction models, Commercial Trip Rates. Trip Distribution: Growth Factor Methods, Gravity Models, Opportunity Models, Time Function Iteration Models.

UNIT-IV

Mode Choice and Traffic Assignment : Mode Choice Behaviour, Competing Modes, Mode Split Curves, Models and Probabilistic Approaches. Traffic Assignment: Basic Elements of Transport Networks, Coding, Route Properties, Path Building Criteria, Skimming Tree, All-or-Nothing Assignment, Capacity Restraint Techniques, Reallocation of Assigned Volumes, Equilibrium Assignment, Diversion Curves.

UNIT-V

Plan Preparation And Evaluation: Travel Forecasts to Evaluate Alternative Improvements, Impacts of New Development on Transportation Facilities. Master plans, Selection of Corridor, Corridor Identification, Corridor deficiency Analysis.

REFERENCES:

1. Introduction to Transportation Planning– M.J. Bruton; Hutchinson of London Ltd.

2. Introduction to Urban System Planning- B.G. Hutchinson; McGraw Hill.

3. Traffic Engineering and Transport Planning- KadiyaliL. R.,Khanna Publishers

4. Lecture note son UTP- Prof. S.Raghavachari, R.E.C.Warangal.

I Year-II Semester		L	T	P	C
		3	0	0	3
	Traffic Analysis and Design				

UNIT-I

Components of Traffic System: Introduction to Traffic Engineering, Human-Vehicle-Road User Environment system, Characteristics of road users, characteristics of vehicles, Characteristics of Pedestrians.

Traffic Data Collection Studies: traffic study components and types of data; volume studies; speed studies; travel time and delay studies; intersection studies; pedestrian studies; parking studies; vehicle detection methods; advanced methods: GPS, Instrumented Vehicles, Image Processing, Bluetooth, Infrared methods, Drone video analysis, Sample selection, and region traffic counts.

UNIT-II

Characteristics of Traffic: Fundamental parameters of traffic and relationships; Time headways, temporal, spatial, and flow patterns; Growth factors; Interrupted and un-interrupted traffic; Microscopic and macroscopic speed characteristics; Vehicular speed trajectories; Speed characteristics- mathematical distributions; Speed and travel time variations.

UNIT-III

Macroscopic Traffic Stream Models: Stream flow fundamentals; family of models; Hydrodynamic and Kinetic Analysis of Traffic; continuity equation; waves in traffic; Traffic fluid state considerations; Platoon diffusion.

Microscopic Traffic Stream Models: Car- following models; Stimulus- response models; distance- based models; psycho physical models; neuro-fuzzy models; gap acceptance models; mixed traffic flow behaviour: non-lane-based movement and challenges of modeling Indian mixed traffic; Hetero geneity in traffic.

UNIT-IV

Highway Capacity Analysis: Capacity and level of service concepts; Factors affecting capacity and LOS; Two-lane, Freeway, and multi-lane capacity analysis; Capacity of Urban arterials; Design and Capacity analysis of Signalized Inter sections; US Highway Capacity Manual (HCM) and IRC standards, Indo-HCM standards.

UNIT-V

Design of Signalized Intersections: Warrants for signalization, design control variables, lost time estimation, saturation flow rate and capacity, dilemma zone analysis, signal timing design methods, pedestrian considerations, queue length and control delay, signal coordination for urban streets, adaptive traffic signals, design examples.

Learning Resources:

Textbooks:

1. Adolf Darling ton May, Traffic Flow Fundamentals, PrenticeHall,1990 (Digitizedin2011).
2. L.R. Kadiyali, Traffic Engineering and Transportation Planning , Khanna Publishers, 2024, Ninth Edition.
3. Partha Chakraborty, Animesh Das, Principles of Transportation Engineering, PHI Learning, 2017, Second Edition.

Reference:

1. C. Jotin Khisty, B. Kent Lall; Transportation Engineering: An Introduction, Pearson Education India, 2016, Third Edition.
2. Fred L .Mannering, Scott S. Washburn; Principles of Highway Engineering and Traffic Analysis, Jhon Wiley & Sons, 2019, 7th Edition.
3. IRC:93-1985, Guideline son Design and Installation of Road Traffic Signals, Indian Roads Congress, New Delhi, 1985.
4. Louis J. Pignataro, Traffic Engineering: Theory and Practice; Prentice Hall, Inc., 1973 (Digitized in 2011).
5. Mike Slinn, Paul Matthews, Peter Guest; Traffic Engineering Design: Principles and Practice, CRC Press, 2005, Second Edition.
6. NASEM, TRB, Highway Capacity Manual: A Guide for Multimodal Mobility Analysis, The National Academies Press, Washington, DC, 2022, Seventh Edition.
7. NicholasJ.Garber,LesterA.Hoel;Traffic and Highway Engineering, Cengage Learning India, 2024, Fifth Edition.
8. Roger P Roess, William RMc Shane ,ElenaS Prassas; Traffic Engineering, Pearson Education, 2020, Fifth Edition.
9. Satish Chandra, S. Gango padhyay, S.Velmurugan, Kayitha Ravinder; Indian Highway Capacity Manual (Indo-HCM), CSIR-CRRI, India, 2017.

Online Resources:

1. https://nptel.ac.in/courses/105/101/105101008
2. https://nptel.ac.in/courses/105/104/105104098
3. https://www.classcentral.com/course/edx-intro-to-traffic-flow-modeling-and-intelligent-transport-systems-12728
4. https://www.crridom.gov.in/sites/default/files/Indo-HCM%20Snippets.pdf
5. https://www.monash.edu/engineering/its/publications/tem2017

I Year-II Semester		L	T	P	C
		3	0	0	3
	Pavement Construction				

UNIT-I

PAVEMENT CONSTRUCTION: Preparation and Construction of Subgrade Soil, Subbase Courses, Base Courses, Bituminous Surface Courses, and Cement Concrete Surface Courses; MORTH specifications, Quality control..

UNIT-II

PAVEMENT INVENTORIES AND EVALUATION: Factors affecting Pavement Deterioration; Functional Condition Evaluation Techniques: Roughness Measurements, Identification of Uniform Sections, Serviceability Concepts: Visual & Ride Rating Techniques, Introduction to Psychometric and Psychophysical Scaling Techniques: Hutchinson's Tracking Task Device Structural Condition Evaluation Techniques: NDT Procedures, Rebound Deflection, Deflection Bowl Measurement and Analysis, Destructive Testing: Remaining Life Concept, Asphaltic Institute's Equivalency Factors

UNIT-III

EVALUATION OF PAVEMENT SAFETY: Importance of Skid Resistance, Factors Affecting Skid Resistance, Skid Resistance Studies, Hydroplaning Reduction with Porous Overlays & Popcorn Friction Overlays; Deterioration Modelling Concepts: Factors Influencing Structural & Functional Condition Deterioration, Examples of Initiation and Progressing Deterioration Models, Use of Deterioration Models by HDM Software

UNIT-IV

PAVEMENT MAINTENANCE & QUALITY CONTROL: Routine, Responsive Maintenance Programmes, Periodic Maintenance, Special Repairs, Rehabilitation and Reconstruction, Objectives & Components of Pavement Maintenance Management System (PMMS), Stages in Implementing PMMS, Total Quality Management (TQM): Quality Assurance/ Quality Control Concepts, Sampling, Tolerances and Controls Related to Profile & Compaction, Role of ISO 9000 in TOM.

UNIT-V

PAVEMENT MANAGEMENT SYSTEM (PMS): Phases and Components of System's Approach, Relationship Between System Approach and PMS, Components and Activities of PMS, Inter- relationships between the different components of PMS, Steps in Implementing PMS, Pavement Investment Planning Approaches: Index Ranking, Benefit Maximization & Cost Minimization Methods, Evaluating Alternative Strategies and Decision Criteria Using HDM Package.

REFERENCES:

1. RCC Haas, W. Ronald Hudson, et al, Modern Pavement Management, Krieger Publishing Company
2. ISTE Summer School Reporton PMSS by Bangalore University, ISTE, New Delhi.
3. Mohammed Y.Shahin, Pavement Management for Airports, Roads & Parking Lots, Chapman & Hall Publishers
4. Instructor's Guide- Asphalt Institute, Asphalt Technology and Construction Practices, Educational series
5. AF Stocks, Concrete Pavements, Elsevier Applied Science Publishers, New York
6. Harold N. Atkins, Highway Materials, Soils & Concrete 3rd Edition, Prentice Hall MORTH, GOI, ―Specifications for Roads & Bridge Works‖, New Delhi

I Year-II Semester		L	T	P	C
		3	0	0	3
Environmental Impact Assessment					

UNIT-I

Introduction: Environment and its interaction with human activities – Environmental imbalances ¬Attributes, Impacts, _Indicators and Measurements - Concept of Environmental Impact Assessment (EIA),Environmental Impact Statement, Objectives of EIA, Advantages and Limitations

UNIT-II

Environmental Indicators - Indicators for climate - Indicators for terrestrial subsystems - Indicators for aquatic subsystems - Selection of indicators - Social-economic indicators - Basic information - Indicators for economy Social indicators-Indicators for health and nutrition-Cultural indicators-Selection of indicators.

UNIT-III

Environmental issues in water resource development - Land use - Soil erosion C1nd their short and long term effects - Disturbance and long term impacts - Changes in quantity and quality of flow ¬Sedimentation – Environmental impact assessment of water resource development structures – Gase studies, Water Quality Impact Assessment - Attributes, Water Quality, Impact Assessment of Water. Resources Projects, Data Requirements of Water Quality Impact Assessment for Dams, Impacts of Dams on Environment, Case Studies.

UNIT-IV

Environmental Issues in Industrial Development: On-site and Off-site impacts during various stages of industrial development, Long term climatic changes, Green house effect, Industrial effluents and their impact on natural cycle, Environmental impact of Highways, Mining'and Energy development

UNIT-V

Methodologies for Carrying Environmental Impact Assessment: Overview of Methodologies .Ad hoc, Checklist, Matrix, Network, Overlays, Benefit Cost Analysis, Choosing A Methodology, Review Criteria.

REFERENCES:

1. Jain, R.K. Urban, L.V.,Stracy,G.S.,(1991),-Environmental Impact Analysis‖, Van Nostr and Reinhold Co., New York

2. Rau ,J. G .and Wooten, D.C., (1996),- Environmental
Impact Assessment‖, McGraw Hill Pub. Co., New York

3. UNESCO,(1987),-Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development‖, UNESCO/UNEP, Paris

4. Canter, L.W.,(1997),-Environmental Impact Assessment‖, McGraw Hill Pub .Co., New York.

I Year-II Semester		L	T	P	C
		3	0	0	3
	Traffic Flow Analysis				

UNIT-I

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

UNIT-II

Traffic Stream Models: Fundamental Equation of Traffic Flow, Speed-Flow-Concentration Relationships, Normalised Relationship, Fluid Flow Analogy Approach, Shock Wave Theory - Flow-Density diagram use in Shockwave analysis; Use of Time-space diagram for shockwave description; Bottleneck situations and shockwaves; traffic signal and shockwave theory; numerical Examples for application of shockwave theory;, Platoon Diffusion and Boltzman Like Behaviour of Traffic Flow, Car-Following Theory, Linear and Non- Linear Car-Following Models, Acceleration Noise, Fuel consumption models

UNIT-III

Queuing Analysis: Fundamentals of Queuing Theory, Demand Service Characteristics, Deterministic Queuing Models, Stochastic Queuing Models, Multiple Service Channels, Analysis of M/M/1 system; Assumptions and Derivation of System State Equations; Application of M/M/1 analysis for parking Garages and Toll Plazas- numerical Examples; Analysis of D/D/1 system for

delay characteristics; Traffic Signal analysis as D/D/1 system; Computation of delays and queue dissipation Time – Numerical Examples.

UNIT-IV

Pedestrian Delays And Gaps: Pedestrian Gap acceptance and delays; Concept of Blocks, Anti-blocks, Gaps and Non-Gaps; Underwood's analysis for Pedestrian Delays; Warrants for Pedestrian Crossing Facilities – Minimum Vehicular Volume Warrant, Minimum Pedestrian Volume Warrant, Maximum Pedestrian Volume Warrant.

UNIT-V

Simulation Models: Philosophy of Simulation Modelling, Formulation of Simulation Model, Methodology of System Simulation, Simulation Languages, Generation of Random Numbers, Generation of Inputs – Vehicle Arrivals, Vehicle Characteristics, Road Geometrics, Design of Computer Simulation Experiments, Analysis of Simulation Data, Formulation of Simulation Problems in Traffic Engineering and Validation.; Basic concepts of simulation modelling application for Signalised Intersections, Pedestrian Crossings and Transit scheduling.

REFERENCES:

1. Traffic Flow Theory: A Monograph, TRB Special Report 165

2. Fundamentals of Transportation Engineering– C.S. Papacostas, Prentice Hall India Publication

3. Principles of Highway Engineering and Traffic Analysis– F.L. Mannering & W.P. Kilareski, John Wiley Publishers.

4. Traffic Flow Fundamentals–A.D. May,, Prentice Hall India Publication

5. Fundamentals of Traffic Engineering– Mc Shane & Rogers

I Year-II Semester		L	T	P	C
		3	0	0	3
	Pavement Evaluation and Rehabilitation				

Unit- I

Functional Evaluation of Pavements: The importance of pavement evaluation; functional condition evaluation techniques: network, project level, and roughness measurement methods; identification of uniform section; serviceability concepts; visual and rating procedures; data collection technologies; pavement deterioration: factors affecting pavement deterioration, modelling, and comparison of different deterioration models.

Structural Evaluation of Pavements: Structural condition evaluation: static, semi-static, moving deflection measuring devices; rebound deflection; deflection bowl measurement and analysis: AASHTO AND IRC over lay design method; back-calculation of layer moduli; ground-penetrating radar evaluation of pavement safety: skid resistance, mobile devices measuring skid resistance and hydroplaning.

UNIT-III

Pavement Rehabilitation: The benefits of recycling: methods, recycling strategies, cold milling, ripping, crushing, recycling batch plant, drum mix plant, mix design, hot in-place recycling techniques, cold in- place recycling; full-depth reclamation, and current practices for improving riding quality.

UNIT-IV

Pavement Maintenance: Surface distresses, types, causes and redial measures, types of maintenance, classification of maintenance activities, pavement maintenance norms maintenance, development of decision tree, decision matrix, Selection of treatment strategies, local, global maintenance and rehabilitation strategies, HDM-4 applications, and life cycle cost analysis.

UNIT-V

Pavement Management with Expert Systems and: Role of computers in pavement management, applications of   expert systems for managing pavements, expert system for pavement evaluation and rehabilitation, knowledge-based expert systems, case studies.

Learning Resources:

Textbooks:
Prithvi Singh Kandhal, A. Veeraragavan, Rajan Choudhary;

1. Bituminous Road Construction in India, PHI Learning Pvt. Ltd., New Delhi, India, 2023, Second Edition.

2. David Croney, Paul Croney; Design and Performance of Road Pavements, Chapman and Hall, 1997, Third Edition.

3. M.Y. Shahin, Pavement Management for Airport, Roads and ParkingLots, Springer, 2006, Second Edition

Reference:
1. A.T. Papagiannakis, E.A. Masad; Pavement Design and Materials, John Wiley and Sons, 2017, First Edition.
2. Ministry of Road Transport and Highways, Specifications for Road and Bridge Works, Indian Roads Congress, New Delhi, India, 2013, Fifth Edition.
3. Rajib B. Mallick, Tahar El- Korchi, Pavement Engineering–Principles and Practice, CRC Press, 2023, 4thEdition.
4. Ralph Haas,W. Ronald Hudson, John P. Zaniewski, Modern Pavement Management, Krieger Publishing Company, Malabar, Florida, USA, 1994.
5. Relevant Indian Road Congress codes, Bureau of Indian Standards, and international standards such as ASTM and AASHTO.
6. Yang H. Huang, Pavement Analysis and Design., Dorling Kindersley (India) Pvt. Ltd., New Delhi, India, 2008, Second Edition.

Online Resources:
1. https://www.pavementinteractive.org/
2. https://www.appliedpavement.com/pavement-evaluation-and-design.html
3. https://freevideolectures.com/course/91/introduction-to-transportation-engineering/40

I Year-II Semester		L	T	P	C
		3	0	0	3
Geosysthetics and Reinforced Earth Structures					

UNIT-I

Geosynthetics and Properties and Testing Methods: Introduction to Geosynthetics –Basic description–History–Manufacturing methods Use sand Applications. Properties and Testing methods of Geotextiles Geo grids – Geo membranes– Geo composites.

UNIT-II

Geotextiles: Designing for Separation–Reinforcement–Stabilization Filtration–Drainage and Moisture barriers.

UNIT-III

Geo grids: Designing for Reinforcement –Stabilization–Designing Gabions– Construction methods –Design of retaining walls.

UNIT-IV

Geo membranes: Survivability Requirements – Pond Liners – Covers for Reservoirs – Canal Liners – Landfill Liners – Caps and closures – Dams and Embankments.

Unit-V

Geo composites: Geo composites–An added advantage–Geo composites in Separation–Reinforcement– Filtration – Geo composites as Geo webs and Geo cells – Sheet drains – Strip drains and Moisture barriers.

REFERENCES:

1. Designing with Geosynthetics by Robert M. Koerner Prantice Hall, Eaglewood cliffs, NJ 07632.

2. Construction and Geotechnical Engineering using Synthetic Fabries‖ by Robert M. Koerner and Josoph P. Welsh. John Willey and Sons, New York.

3. Engineering with Geosynthetics‖, by G. Venkatappa Rao and GVS Suryanarayana Raju– Tata McGraw Hill Publishing Company Limited New Delhi.

4. Foundation Analysis and Design‖ by J.E. Bowles McGraw Hill Publications.

I Year-II Semester		L	T	P	C
		3	0	0	3
	Highway Safety Engineering				

UNITI

Introduction to safety:

Road accidents, Trends, causes, Collision diagrams; Highway safety; Human factor sand road user limitations; Speed and itself factor road safety; Vehicle factors; Highway safety in India. Multi-causal dynamic systems approach to safety; Crash Vs Accident; Road safety improvement strategies; Elements of a road safety plan, Safety data Needs; Safe vehicle design.

UNITII

Statistical Interpretation and Analysis of Crash Data:

Before-after methods in crash analysis, Recording of crash data; Accident Investigation and Analysis; Statistical testing and the role of chance; Black Spot Identification and Investigations, Case Studies.

UNITIII

Road Safety Audits:

Key elements of a road safety audit, Road Safety Audits & Investigations, Work zone safety audit; Crash investigation and analysis, Methods for identifying hazardous road locations, Case Studies.

UNITIV
Crash Reconstruction:

Describethebasicinformationthatcanbeobtainedfromtheroadwaysurface,Understand basicphysicsrelatedtocrashreconstruction,speedforvariousskid,friction,drag,and accelerationscenarios,variablesinvolvedinjumpandflipcrashes,variablesinvolvedin pedestrian crashes, Case Studies.

UNITV

Mitigation Measures:

Accident prevention by better planning, Accident prevention by better design of roads, Crash Counter measures, Highway operation and accident control measures, Highway Safety Measures during construction, Highway geometry and safety; Safety in urban areas; Public transport and safety; Road safety policy making, Stakeholders involvement; Road safety law.

References:

1. Athelstan Popkess, Traffic Control and Road Accident Prevention, Chapman and Hall, 1997 (Digitized 2008)
2. Ezra Hauer, Observational Before-After Studies in Road Safety, Pergamon Press, 1997 (reprinted2002).
3. Geetam Tiwari and Dinesh Mohan, Transport Planning and Traffic Safety: Making Cities, Roads, and Vehicles Safer, CRC Press, 2016.
4. Institute of Transportation Engineers (ITE), The Traffic Safety Toolbox: A

Primeron Traffic Safety, ITE, 1999.

5. J. Stannard Baker, Traffic Collision Investigation, North western University Center for Public Safety, 2002.
6. Ken W. Ogden, Safer Roads: A Guide to Road Safety Engineering. Avebury Technical,1996.
7. Leonard Evans, Traffic Safety, Science Serving Society,2004.
8. Lynn B. Fricke, Traffic Crash Reconstruction, Second Edition, Northwestern University Center for Public Safety, 2010.
9. Rune Elvik and Truls Vaa, The Handbook of Road Safety Measures, Elsevier, 2004.
10. Towards Safe Roads in Developing country, TRL – ODA, 2004. 11. IRC: SP: 55-2014 Guidelines of Traffic Management in work zones
11. IRC:SP: 88-2019 Manual on Road safety audit

IYear-II Semester		L	T	P	C
		3	0	0	3
IntelligentTransportationSystem					

UNIT-I

Fundamentals of ITS: Definition of ITS s, The historical context of ITS from both public policy and market economic perspectives, Types of ITS; Historical Background, Benefits of ITS

UNIT-II

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

UNIT-III

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

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

UNIT-IV
ITS Architecture – Regional and Project ITS architecture; Concept ofoperations; ITS Models and Evaluation Methods; Planning and human factor issues for ITS, Case studies on deployment planning and system design and operation;ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS planning

UNIT-V

ITS applications: Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.; Transportation network operations; commercial vehicle operations and intermodal freight; public transportation applications; ITS and regional strategic transportation planning, including regional architectures: ITS and changing transportation institutions 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 developingcountries

REFERENCES:

1. FundamentalsofintelligenttransportationsystemsplanningByMashrurA.Chowdhury,AdelWadidSadek

2. LawrenceA.Klein,SensortechnologiesandDatarequirementsofITS

3.   ITSHandBook2000:RecommendationsforWorldRoadAssociation(PIARC)byKanPaulChen,John Miles.

4. Sussman,J.M.,PerspectiveonITS,ArtechHousePublishers,2005.

5. NationalITSArchitectureDocumentation,USDepartmentofTransportation,2007

I Year-II Semester		L	T	P	C
		3	0	0	3
	Public Transportation Systems				

UNIT-I

Transit Systems: Role of Transit - Types of Transit Modes - Buses - LRT, RTS - Air-cushioned and MaglevSystem –S-BahnDualModeBusses,ParaTransit -Dial-a-Ride-Taxi-JitneyandRidesharing –PRTNetworks-DRTSTechnologicalCharacteristics–Resistances,acceleration&velocityProfiles – Operational characteristics speed, capacity & payloads – Route capacity – Comfort conditions - Performancerelationships-PublicandPrivateOperations-ModesforIntercityTransport;Coefficientof rolling friction, modes comparison, system configurations, system performance calculations.

UNIT-II

EstimationofTransitDemand: Datarequirementsandcollectiontechniques,ConventionalMethods— destinationSurvey—busStopSurveysandAnalysis—modeSplitModels—captiveandChoiceRiders— attitudes of Travelers—patronage Determination.

Bus Route Network Planning: Route Systems - Route Location, Route Structure, Route Coding Techniques, Route Capacity - Planning of Transit Network - Different Types - Service Area Coverage - Evaluation - Selection of Optimal Network - Path Building Criteria - Integration with UTPS.

UNIT-III

BusScheduling:patternsofBusServices,FrequencyofServices,SpecialServices,SingleRouteBus Scheduling, Fleet Requirement, Marginal Ridership Concept, Use of Optimization Technique, Load Factor, Depot Location, and Spacing of Bus Stops.

Mass Transit Corridor Identification & Planning: Corridor identification - Network Compression Method- Planningof Rapid Transit System - System Selection - SupportingandEnclosingStructures - System Evaluation - Track Structures - Signal System - Aesthetics and Noise Consideration - Cost of Construction - Station Arrangements - Platform Capacity - Fare Collection, Transit Marketing.

UNIT-IV

Public Transport Management Measures: RTC Act - ASRTU System Efficiency and Effectiveness Measures - Performance Indicators – LOPTS - Preferential Treatment to HOV: Exclusive Bus Lanes - Bus Streets - Contra Flows - Reversible Lanes - Bus Bypass - Bus Pre-emption Signals for Bus Operations.

UNIT-V

TransitTerminalsandPerformanceEvaluation: TransitTerminalPlanningandDesign–Performance Evaluation–Efficiency,Capacity,ProductivityandUtilization–PerformanceEvaluationTechniquesand Application – System Network Performance; Safety and security, hazard analysis of Bus transit.

LearningResources:

Textbooks:

1. PeterR.White,PublicTransport:ItsPlanning,Management,andOperation,LondonNewYork,2008 , Fifth Edition.
   2. VukanR.Vuchic,UrbanTransit:Operations,Planning,andEconomics,Wiley,

2017. Reference Books:

1. AlanBlack,UrbanMassTransportationPlanning,McGraw-HillInternational,1995.
2. AshishVerma,T.V.Ramanayya;PublicTransportPlanningandManagementinDeveloping Countries, CRC Press, 2014.
3. BarryJohnSimpson,UrbanPublicTransportToday,Taylor&FrancisRoutledgePublisher,2003.
4. Carlos F Daganzo, Yanfeng Ouyang; Public Transportation Systems: Principles of System Design, Operations Planning and Real-time Control, World Scientific Publishing Company, 2019.
5. David A. Hensher, Bus Transport: Economics, Policy, and Planning, Research in TransportationEconomics Volume 18. Elsevier Publications, 2007.
6. DavidJohnsonVictor,S.Ponnuswamy;UrbanTransportation:Planning,Operationand Management, McGraw-Hill Education, 2012.
7. GeetamTiwari,UrbanTransportforGrowingCities:High-CapacityBusSystem,MacMillanIndiaLtd., 2002.
8. George E. Gray and Lester A. Hoel, Public Transportation: Planning, Operation and Management, Prentice Hall; 1992, Second Edition.

OnlineResources

1. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-258j-public-transportation-systems-spring-2017/index.htm?utm_source=OCWCourseList&utm_medium=CarouselSm&utm_campaign=FeaturedCourse
2. https://www.apta.com/
3. https://www.uitp.org/

IYear-II Semester		L	T	P	C
		3	0	0	3
AdvancedTransportationEngineeringLab					

1. VolumeStudies–StraightRoadsandatIntersections

2. SpeedStudies-SpotSpeedStudiesbyStopWatch,EnosocpeandRadar SpeedMeter

3. JourneyTimeandDelayStudies-FloatingCarMethod

4. ParkingSurveysandParkingTurnover Studies

5. StudyofGapsandLags–CriticalGapsandLagsat Intersections

6. DelayMeasurementatSignalisedandUnsignalisedIntersections

7. TrafficDiversionAnalysisusingdiversioncurves.

8. VideographySurvey.

9. RoadsafetyAudit.

10. MiniProjectbasedonabove studies.

IYear-II Semester		L	T	P	C
		3	0	0	3
TransportationSimulationLab					

1. DrivertestingExperiments
2. Intersectiondesigns
3. SignalDesign.
4. OriginandDestinationStudies
5. ComputerSoftware:PrinciplesofTRIPS,CUBE,DemoVersions,Casestudies.
6. TrafficSimulationstudiesusingVISSIM.
7. Cellularapplications.
8. AccidentStudies.

Semester - III	Program Elective - V	L	T	P	C
Course Code	**RESEARCH METHODOLOGY AND IPR**	3	0	0	3

Unit 1 : RESEARCH PROBLEM AND SCOPE FOR SOLUTION

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

Unit 2 : FORMAT

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

Unit 3 : PROCESS AND DEVELOPMENT

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

Unit 4 : PATENT RIGHTS

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 5 : NEW DEVELOPMENTS IN IPR

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Textbooks :

Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"

 Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

Ranjit Kumar, 2nd Edn, "Research Methodology: A Step by Step Guide for beginners"

References :

Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.

Mayall, "Industrial Design", McGraw Hill, 1992.

Niebel, "Product Design", McGraw Hill, 1974.

Asimov, "Introduction to Design", Prentice Hall, 1962.

Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

IIYear-ISemester		L	T	P	C
		0	0	3	3
	SUMMER INTERNSHIP/ INDUSTRIAL TRAINING				

IIYear-ISemester		L	T	P	C
		0	0	20	10
	DISSERTATION-PartA				

IIYear-IISemester		L	T	P	C
		0	0	32	16
	DISSERTATION/THESIS-PartB				