NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

Honors in

Transportation Engineering

SCHEME OF INSTRUCTION AND SYLLABI

(for students of B.Tech., Civil Engineering)

(Effective from 2021-22)

DEPARTMENT OF CIVIL ENGINEERING

SCHEME OF INSTRUCTION

Honours Program – Transportation Engineering

S. No.	Course Code	Name of the Course	L	T	P	Credits	Sem.
1	CE5601	Urban Transportation Planning	3	0	0	3	V
2	CE5651	Land Use and Transportation Planning	3	0	0	3	VI
3	CE5653	Pavement Analysis and Design	3	0	0	3	VI
4	CE5602	Traffic Analysis and Design	3	0	0	3	VII
5	CE5604	Transportation Data Analysis	3	0	0	3	VII
6	CE5654	Road Safety Engineering	3	0	0	3	VIII
		Total				**18**	

DETAILED SYLLABUS

Honors

Transportation Engineering

Course Code: CE5601	URBAN TRANSPORTATION PLANNING	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify urban transportation problems.
CO2	Develop data base for calibration of travel demand models.
CO3	Estimate urban travel demand.
CO4	Plan urban transport networks.
CO5	Identify urban transport corridors and prepare urban transportation plans.

Syllabus:

Urban Transportation Problems and Policy: Urban transportation Issues, Travel Characteristics, Evolution of Planning Process, Supply and Demand – Systems approach; NUTP, Recommendations of 12th FYP and NTDP; Smart Cities, Service Level Benchmarks.

Travel Demand Approaches: Trends, Overall Planning process, Long term Vs. Short-term planning, Types of Plans, Master Plans, Demand Function, Independent Variables, Travel Attributes, Assumptions in Demand Estimation, Sequential, and Simultaneous Approaches, Aggregate and Disaggregate Techniques, UTPS Approach.

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.

Trip Generation: Trip Generation Analysis: Zonal Models, Category Analysis, Household Models, Trip Attraction models, Commercial Trip Rates.

Trip Distribution: Trip Distribution: Growth Factor Methods, Gravity Models, Opportunity Models, Time Function Iteration Models.

Mode Split: Mode Choice Behaviour, Competing Modes, Mode Split Curves, Models, and Probabilistic Approaches.

Traffic Assignment: 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.

Corridor Identification - Plan Preparation and Evaluation: Selection of Corridor, Corridor Identification, Corridor deficiency Analysis; Multimodal Transportation Planning, TOD; Travel Forecasts to Evaluate Alternative Improvements, Impacts of New Development on Transportation Facilities; Pivot Point Analysis, Environmental and Energy Analysis.

Learning Resources:

Textbooks:

1. Transportation Engineering and Planning; Papacostas, C.S. and Prevedouros, P.D., Prentice Hall of India Pvt. Ltd., 2012, Third Edition.
2. Transportation Engineering, Khisty C.J. and B Kent Lall; Prentice Hall of India Pvt. Ltd., 2012, Third Edition.
3. Urban Transportation Planning Lecture Notes, Chari, S.R., NIT Warangal, 1990.

Reference Books:

1. An Introduction to Transportation Planning (The Living Environment), Bruton MJ; UCL Press, London, UK; 2000.
2. Modelling Transport, Ortuzar J de D and LG Willumsen; New York: John Wiley and Sons, 2001, Third Edition.
3. Principles of Urban Transportation System Planning; Hutchinson BG; McGraw Hill, 1974.
4. Transportation Planning Handbook, John D Edwards; Institution of Transportation Engineers, 1999, Second Edition.
5. Urban Transportation Planning: A decision-oriented Approach, Mayer MD and Miller EJ; McGraw Hill, 2001, Second Edition.

Online Resources:

1. http://www.nptelvideos.in/2012/11/urban-transportation-planning.html
2. https://nptel.ac.in/courses/105107067/
3. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-252j-urban-transportation-planning-fall-2016/
4. https://olc.worldbank.org/content/integrated-urban-transport-planning-self-paced

Course Code: CE5651	LAND USE AND TRANSPORTATION PLANNING	Credits 3-0-0: 3

Pre-requisites: Urban Transportation Planning

Course Outcomes: At the end of the course, the student will be able to:

CO1	Differentiate various urban forms & structures.
CO2	*Develop land use models.*
CO3	Prepare integrated land use and transportation plans for a city.
CO4	*Identify transit corridors in a city.*
CO5	*Apply TOD principles to enhance public transit share.*

Syllabus:

Urban Forms & Structures: Urbanization and Migration, Findings of Commission on Urbanization, Urban forms: Garden City, Linear city, Radburn, Urban Neighborhood, Precinct, MARS, Le Corbusier, Collin Buchanan, etc. Urban structures: Centripetal type, Grid type, linear type and directional grid type, Evolution of spatial structure

Land Use Models: Von Thunen's regional land use model, Concentric urban land use model, Sector land use model, multiple nuclei land use model, hybrid land use models, Cellular automata models, and land rent theory; Christaller central place theory- Losch's improvements; Urban regions

Land Use Transportation Models: Classification of LUT Models, Economic Base Mechanism, Allocation Mechanism and Spatial Allocation and Employment Relationships, Garin Lowry Models, Contribution by Putman and Wilson, Issues Related to Land use Transport - Interaction, Case Study Examples.

Transit Corridors: Mass Transit Classifications, Transit System Characteristics, Capacity and LOS of urban transit, transit modal options, Transit routes and networks, Planning Concerns and guidelines

Transit Oriented Development: Introduction to Transit based development / Transit oriented development (TOD), TOD policy, Principles of TOD, Approach for TOD Implementation, TOD Typology, TOD Standards, Station Area Planning

Learning Resources:

Textbooks:

1. Integrated Landuse and Transport Modelling: Decision Chains and Hierarchies, Barra, T. D., Cambridge University Press, 2005.
2. The Land Use Transport System, Blundon, W. R. and J Black, Australian Natl Univ Press, 1984, Second Edition.
3. Transit-Oriented Development: Making it Happen, Carey Curtis, John L. Renne, and Luca Bertollnl, Routledge, 2016, First Edition.

Reference Books:

1. Land use Transportation Planning, Lecture Notes, Chari, S. R., REC, Warangal, 1988.
2. Principles of Urban Transportation System Planning; Hutchinson BG; McGraw Hill, 1974.
3. Transportation Planning Handbook, John D. Edwards, Institution of Transportation Engineers, 1999, Second Edition.
4. The Geography of Transport Systems, Jean-Paul Rodrigue, Dept. of Global Studies & Geography, Hofstra University, New York, USA, 2013, Third Edition.

Online Resources:

1. http://www.tod.org/
2. https://nptel.ac.in/courses/124/105/124105016/
3. https://www.classcentral.com/course/swayam-urban-landuse-and-transportation-planning-20017
4. https://www.vtpi.org/tdm/tdm45.htm

Course Code: CE5653	PAVEMENT ANALYSIS AND DESIGN	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze stresses and strains in a flexible pavement using multi-layered elastic theory, and KENLAYER.
CO2	Compute stresses and strains in a rigid pavement using Westergaard's theory, and KENSLABS.
CO3	Design a flexible pavement using various methods.
CO4	Design a rigid pavement using various methods.

Syllabus:

Pavement Types and Materials: Types and component parts of pavements; highway and airfield pavements; basic characteristics of materials used in pavements

Stresses in Flexible Pavements: Layered system concepts; stress solution for one, two and three layered systems; fundamental design concepts; stress analysis in flexible pavements using KENLAYER

Stresses in Rigid Pavements: Westergaard's theory and assumptions; joints in rigid pavements; stresses due to curling, stresses and deflections due to loading, frictional stresses; stresses in dowel bars and tie bars, dowel group action; stress analysis in rigid pavements using KENSLABS.

Factors Affecting Pavement Design: Variables considered in pavement design; classification of axle types, standard and legal axle loads, tyre pressure, contact pressure, ESWL, EWLF and EAL concepts; traffic analysis: ADT, AADT, truck factor, growth factor, lane distribution factor, directional distribution factor and vehicle damage factor.

Design of Flexible Pavements: IRC method of flexible pavement design; Asphalt Institute's design methods with HMA and other base combinations; AASHTO method of flexible pavement design; design of flexible pavement shoulders; introduction to mechanistic-empirical pavement design guide.

Design of Rigid Pavements: IRC method of plain jointed, jointed reinforced, continuously reinforced rigid pavement design; design of conventional and thin whitetopping; AASHTO method of rigid pavement design; design of rigid pavement shoulders.

Learning Resources:

Text Books:

1. Pavement Analysis and Design, Huang, Y.H., Dorling Kindersley (India) Pvt. Ltd., New Delhi, India, 2008, Second Edition.
2. Principles of Pavement Design, Yoder, E.J., and Witczak, M.W., Wiley India Pvt. Ltd., New Delhi, India, 2012, Second Edition.

Reference Books:

1. Guidelines for Conventional and Thin Whitetopping, IRC: SP: 76, Indian Roads Congress, New Delhi, India, 2015, First Revision.
2. Guidelines for Design and Construction of Continuously Reinforced Concrete Pavement, IRC: 118, Indian Roads Congress, New Delhi, India, 2015.

3. Guidelines for the Design of Flexible Pavements, IRC: 37, Indian Roads Congress, New Delhi, India, 2018, Fourth Revision.
4. Guidelines for the Design of Plain Jointed Rigid Pavements for Highways, IRC: 58, Indian Roads Congress, New Delhi, India, 2015, Fourth Revision.
5. Thickness Design – Asphalt Pavements for Highways and Streets, Manual Series No. 1, Asphalt Institute, Kentucky, USA, 1999, Ninth Edition.

Online Resources:

1. http://onlinepubs.trb.org/onlinepubs/archive/mepdg/guide.htm
2. http://www.trb.org/Pavements/TRBPublications.aspx
3. https://link.springer.com/article/10.1007/BF03325749
4. https://pavementinteractive.org/

Course Code: CE5602	TRAFFIC ANALYSIS AND DESIGN	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Estimate basic characteristics of traffic stream.
CO2	Explore various methods of traffic data collection.
CO3	Model traffic stream behavior at micro and macro level.
CO4	Determine the capacity of highways.

Syllabus:

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, 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; Region traffic counts.

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.

Macroscopic Traffic Stream Models:
Stream flow fundamentals; family of models, Hydrodynamic and Kinematic Analysis of Traffic; Continuity equation; Waves in traffic, Traffic fluid state considerations; Platoon diffusion.

Microscopic Traffic Stream Models:
Car-following models: Stimulus-response; Distance-based models; Psycho-physical models, Neuro-Fuzzy models; Gap acceptance models; Mixed traffic flow behavior: Non-lane based movement and challenges of modeling Indian mixed traffic, Heterogeneity in traffic.

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 Intersections; US Highway Capacity Manual (HCM) and IRC standards, Indo-HCM standards.

Design of Signalized Intersection:
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. Principles of Transportation Engineering, Partha Chakraborty, and Animesh Das, PHI Learning, 2017, Second Edition.

2. Traffic Engineering and Transportation Planning, Kadiyali L.R., Khanna Publishers, 2011, Ninth Edition.
3. Traffic Flow Fundamentals, May, A.D., Prentice Hall, 1990 (Digitized in 2007)

Reference Books:

1. Highway Capacity Manual, Transportation Research Board, Washington, D.C., 2010.
2. Indian Highway Capacity Manual (INDO-HCM), Chandra, Satish, Gangopadhyay, S, Velmurugan, S, Ravinder, Kayitha, CSIR-CRRI, 2017.
3. IRC 93: 1985, Guidelines on Design and Installation of Road Traffic Signals.
4. Principles of Highway Engineering and Traffic Analysis, Fred L. Mannering, and Scott S. Washburn, Jhon Wiley & Sons, 2013, Fifth Edition.
5. Traffic and Highway Engineering, Nicholas J. Garber, and Lester A. Hoel, Cengage Learning India, 2015, Fifth Edition.
6. Traffic Engineering Design: Principles and Practice, Mike Slinn, Paul Matthews, Peter Guest, Butterworth-Heinemann, 2005, Second Edition.
7. Traffic Engineering, Roger P. Roess, Elena S. Prassas, and William R. McShane, Pearson, 2019, Fifth Edition.
8. Traffic Engineering: Theory and Practice; Pignataro L.J., Prentice Hall, Inc., 1973 (Digitized in 2011)
9. Transportation Engineering, Khisty C.J., and Kent Lall, B., Prentice Hall of India Pvt. Ltd., 2012, Third Edition.

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

Course Code: CE5604	TRANSPORTATION DATA ANALYSIS	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Select suitable method for processing and presentation of transportation data.
CO2	Apply probability distributions to analyze transportation data.
CO3	Choose appropriate hypothesis testing measures.
CO4	Analyze multivariate transportation data.
CO5	Differentiate various curve fitting techniques.
CO6	Develop Time Series models.

Syllabus:

Data Description and Presentation: Type of data, a center of data, quartiles, five-number summary, the spread of data, coefficient of variation and standard deviation, a measure of dispersion, shape of data, coefficients of skewness and kurtosis, descriptive data statistics, presentation of categorical, quantitative and qualitative variable, data frequency and histogram, exercises with actual data.

Probability Laws and Distributions: Basic probability theory, concept and rules, Bayes' theorem, type of statistical distribution and characteristic, probabilistic distributions- Binomial, Poisson, Normal, Lognormal, Weibull, Gamma, Beta, Erlang, Student's t and F distribution, Geometric and Hyper geometric distribution, applications in transportation engineering.

Statistical Inference and Tests of Significance: Hypothesis testing, types of error in hypothesis, confidence interval, significance tests for comparing variances and means, tests with small and large samples, two-tail and one-tail student's t-test, analysis of variance (ANOVA), non-parametric tests (Chi-square test and Kolmogorov–Smirnov test), central limit theorem, practice with transportation data.

Sampling Techniques: Sample surveys, census, sampling bias, random sampling, stratified sampling, sequential sampling, cluster sampling, systematic sampling, sampling on successive occasions, non-sampling errors, applications in transportation engineering.

Regression and Correlation: Simple linear regression, residuals and variances, multiple linear regression, two-stage regression, forward, backward and step-wise regression, residual analysis, correlation analysis, type of correlations, coefficient of correlation, Karl-Pearson's coefficient, multivariate data analysis, factor analysis, applications in transportation engineering.

Parameter Estimation and Curve Fitting Techniques: Least square, generalized least squares, method of moments, maximum likelihood, algebraic and geometric curve fit, linear and non-linear curve fitting (polynomial, exponential, logarithmic, power, etc.), overfit, and under fit.

Time Series Models: Time series concept and components, utility, time series models, measurement of time series, graphical method, method of semi-average, moving average, least square, linear, parabolic and logarithmic trends, growth curves, ratio-to-trend and link relative method for seasonal variation, exercises with transportation data.

Learning Resources:

Textbooks:

1. Statistical and Econometric Methods for Transportation Data Analysis, Washington, S.P., Karlaftis, M.G., Mannering, F., Anastasopoulos, P., CRC Press, 2020, Third Edition.
2. Statistical Techniques for Transportation Engineering, Molugaram, K., Rao, G.S., Shah, A., Davergave, N., Butterworth-Heinemann, 2017, First Edition.

Reference Books:

1. Multivariate Data Analysis, Joseph F.H., William C.B., Barry J.B., Anderson, R.E., Prentice Hall, 2018, Eighth Edition.
2. Probability and Statistical Inference, Robert V.H., Elliot, T., Zimmerman, D., Pearson, 2021, Tenth Edition.
3. Probability Concepts in Engineering Planning and Design, Alfredo H.S.A., Tang, W.H., Volume I & II, John Wiley & Sons, Singapore, 2007.
4. Quality Improvement through Statistical Methods, Bovas A., Springer Science & Business Media, 2012.

Online Resources:

1. http://courses.washington.edu/cee412/
2. https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability

Course Code: CE5654	ROAD SAFETY ENGINEERING	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze the effect of user, roadway and environment characteristics on traffic safety.
CO2	Plan and design of road safety improvement programs.
CO3	Evolve safety measures using accident data.
CO4	Conduct road safety audit.
CO5	Interpret accident data using statistical analysis.

Syllabus:

Basics of Road Safety: Road accidents, Trends, Global and Indian level, Crash Causation, Collision diagrams; Highway safety; Human factors and road user limitations; Speed and its effect on road safety; Vehicle factors; Highway safety in India.

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, Hot spot analysis, Case Studies.

Road Safety Management System: Multi-causal dynamic systems approach to safety; Crash Vs. Accident; Road safety improvement strategies; Elements of a road safety plan, Speed management, Safety data Needs; Intersection Safety, Safe vehicle design.

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.

Crash Reconstruction: Describe the basic information that can be obtained from the roadway surface, Basic physics related to crash reconstruction, speed for a various skid, friction, drag, and acceleration scenarios, variables involved in jump and flip crashes, variables involved in pedestrian crashes, Case Studies.

Mitigation Measures: Accident prevention by better planning, Accident prevention by better design of roads, Crash Countermeasures, Highway operation, and accident control measures, Highway Safety Measures during construction, Highway geometry, and safety; Design of Forgiving roads and self-explaining roads, Effective Road Signs and Street Lighting, Safety in urban areas; Public transport and safety; Road safety policy-making, Stakeholders involvement; Road safety law.

Learning Resources:

Textbooks:

1. Observational Before-After Studies in Road Safety, Ezra Hauer, Pergamon Press, 1997 (Reprinted 2002).
2. Traffic Safety, Leonard Evans, Science Serving Society, 2004.
3. Transport Planning and Traffic Safety: Making Cities, Roads, and Vehicles Safer, Geetam Tiwari, and Dinesh Mohan, CRC Press, 2016, First Edition.

Reference Books:

1. The Handbook of Road Safety Measures, Rune Elvik and TrulsVaa, Elsevier, 2004.
2. The Traffic Safety Toolbox: A Primer on Traffic Safety, ITE, 1999.
3. Towards Safe Roads in Developing countries, TRL–ODA, 2004.
4. Traffic Accident Reconstruction, Lynn B. Fricke, Northwestern University Center for Public Safety, 1990.
5. Traffic Collision Investigation, J. Stannard Baker, Northwestern University Center for Public Safety, 2002.
6. Traffic Control and Road Accident Prevention, Popkess C.A, Chapman and Hall, 1997.

Online Resources:

1. http://tripp.iitd.ernet.in/publication/report
2. https://atpio.org/webinar-on-addressing-road-safety-worldwide-vulnerable-road-users-human-factors-rs-in-lmic/
3. https://ebrdelearning.com/course
4. https://morth.nic.in/reports-working-group-4-es-road-safety-0
5. https://vimeo.com/294277710
6. https://www.ptvgroup.com/en/solutions/products/ptv-visum/ptv-visum-safety/
7. https://www.who.int/data/gho/data/themes/road-safety
8. https://www.who.int/teams/social-determinants-of-health/safety-and-mobility/decade-of-action-for-road-safety-2021-2030