भारतीय प्रौद्योगिकी संस्थान भुवनेश्वर

INDIAN INSTITUTE OF TECHNOLOGY BHUBANESWAR

School of Infrastructure

Curriculum and Syllabus for

M. Tech. (Transportation Engineering)

Preceding Degree:

B.E / B.Tech or equivalent degree in Civil Engineering

Intake per year: 15 students

Compliance Report of M. Tech. (Transportation Engineering) Curriculum

Components	**Subjects**	**As per 64th Senate**		**Proposed Credit Structure for M.Tech (Transportation Engineering)**	
		Nos.	**Credits**	**Nos.**	**Credits**
Theory	Total	9 to 10 Nos.	-	9 Nos.	30-35
	Departmental Core courses	-	-	4	16
	Electives	-	-	5	15-20
Labs		3 to 4 Nos.	-	3 Nos.	6
Seminar		-	-	1 No.	2
Thesis		3 Parts	2+14+14	3 Parts	30
Total Credits			65-74		69-74

Curriculum for M.Tech. (Transportation Engineering)

M.Tech. Curriculum					
Subject Name	**Course Code**	**Type**	**L-T-P**	**Credit**	**Contact Hours**
Semester-1					
Pavement Materials and Characterization	CE6L401	DC	3-1-0	4	4
Urban Transportation Planning	CE6L403	DC	3-1-0	4	4
Department elective 1/ Open elective 1	CE6LXXX	DE1/OE1	3-0-0 / 3-1-0	3 / 4	3 / 4
Department elective 2/ Open elective 2	CE6LXXX	DE2/OE2	3-0-0 / 3-1-0	3 / 4	3 / 4
Department elective 3/ Open elective 3	CE6LXXX	DE3/OE3	3-0-0 / 3-1-0	3 / 4	3 / 4
Seminar	CE6S401	Seminar	0-0-0	2	0
Pavement Materials Laboratory	CE6P401	Lab	0-0-3	2	3
			Total	**21 / 24**	**20 / 23**
Semester-2					
Fundamentals of Traffic Flow Theory	CE6L402	DC	3-1-0	4	4
Analysis and Design of Pavements	CE6L404	DC	3-1-0	4	4
Department elective 4/ Open elective 4	CE6LXXX	DE4/OE4	3-0-0 / 3-1-0	3 / 4	3 / 4
Department elective 5/ Open elective 5	CE6LXXX	DE5/OE5	3-0-0 / 3-1-0	3 / 4	3 / 4
Traffic Engineering Studies	CE6P402	Lab	0-0-3	2	3
Transportation Systems Planning Studio	CE6P404	Lab	0-0-3	2	3
Thesis Part 1 (Literature Review)	CE6D401	Thesis Part - 1	-	2	-
			Total	**20 / 22**	**20 / 22**

Industrial Internship (Optional)*

Semester-3					
Thesis Part 2	CE6D402	MTP	-	14	-
			Total	**14**	
Semester-4					
Thesis Part 3	CE6D403	MTP	-	14	-
			Total	**14**	
			Total Credits:	**69/74**	

*Industrial internship is an optional subject included in the curriculum for the benefit of the student and does not carry any credit. The duration of this internship shall be a maximum of six months. The student is permitted to go for an industrial internship based on the consent from the allotted supervisor after the completion of the second semester from the month of May, which shall continue up to the month of October.

Tentative plan for the M.Tech thesis evaluation.		
M.Tech Thesis	M.Tech Student (With no industrial internship)	M.Tech Student (With industrial internship)
Part-I	During the second semester	During the second semester
Part-II	November or December (Autumn)	Jan or Feb (Spring)
Part-III	April or May (Spring)	June or July (During summer vacation)

List of Electives (I to V)*				
Subject Name	**Subject Code**	**L-T-P**	**Credit**	**Contact Hour**
Design of Transportation Facilities and Safety	CE6L451	3-1-0	4	4
Economic Evaluation of Transportation System	CE6L452	3-0-0	3	3
Analysis of Transportation System	CE6L453	3-0-0	3	3
Pavement Evaluation and Management	CE6L454	3-1-0	4	4
Airport Planning and Design	CE6L455	3-0-0	3	3
Public Transportation System	CE6L456	3-0-0	3	3

*Any other subjects of the same level offered by any other specializations of SIF or any other Schools can also be taken as an elective, as suggested by faculty advisor/PG Coordinators.

SYLLABUS

Subject Code: CE 6L403	Subject Name: Pavement Material Characterization	L-T-P: 3-1-0	Credit: 04

Pre-requisite(s): None

Subgrade Soil: Classification, desirable properties, determination of soil strength characteristics, resilient modulus, Road aggregates: classification, properties of aggregates, design of aggregate gradation, Bituminous road binders: bitumen, emulsions, cut backs and modified binders, Rheology of bituminous binders, modified binders, Hot mix, Warm mix and Cold mix Bituminous constructions, Mix design: Marshall method and SuperPave procedure, Visco-elastic and fatigue properties of bituminous mixtures, Requirements of paving concrete, design of mixes for recycling of bituminous and concrete pavement surfaces.

Text/Reference Books:

1. A. T. Papagiannakis and E. A. Masad, Pavement Design and Materials, Wiley Publications
2. J. Read and D. Whiteoak, The Shell Bitumen Handbook, 5th edition, Thomas Telford Ltd
3. Asphalt Institute, Asphalt Binder Handbook, Manual Series No. 2 (MS-26). Asphalt Institute. Lexington, KY
4. Asphalt Institute. Mix Design Methods for Asphalt, Manual Series No. 2 (MS-02). Asphalt Institute. Lexington, KY
5. Rajib B. Mallick, Tahar El-Korchi Pavement Engineering: Principles and Practice, Second Edition, CRC Press
6. Roberts, F.L.; Kandhal, P.S.; Brown, E.R.; Lee, D.Y. and Kennedy, T.W. Hot Mix Asphalt Materials, Mixture Design, and Construction. National Asphalt Pavement Association Education Foundation. Lanham, MD

Subject Code: CE 6L401	Subject Name: Urban Transportation Planning	L-T-P: 3-1-0	Credit: 04

Pre-requisite(s): None

Fundamental of transport system planning and its process; Basic concept of trip based demand model; Features of urban transport network and its various components; basics of graph theory and its application; concept of urban travel demand and concept of sequential/non-sequential travel demand model; steps of urban travel demand forecasting models such as trip generation, trip distribution, modal split and trip assignment; basics of micro-simulation assisted travel demand model; land use transport model; urban goods movement.

Text/Reference Books:

1. L.R. Kadiyali, Traffic Engineering and Transport Planning
2. Williumsen and Ortuzar, Modelling Transport
3. Kanafani, Transp. Demand Analysis.
4. B.G. Hutchinson, Principles of Urban Transport System Planning

Marvin L. Manheim, Fundamentals Of Transportation Systems Analysis, Volume 1.

Subject Code: CE6P401	Subject Name: Pavement Materials Laboratory	L-T-P: 0-0-3	Credit: 02

Pre-requisite(s): None

Tests on Soils: Density of soil, CBR, Determination of Field CBR using Dynamic Cone Penetrometer

Tests on Aggregate: gradation, shape tests, specific gravity, water absorption, aggregate crushing value, Los Angeles abrasion value, aggregate impact value.

Tests on Bitumen: penetration, viscosity, flash and fire point, ductility and elastic

recovery, softening point, specific gravity, Ageing of Bitumen, Rheology of Bitumen using Dynamic Shear Rheometer

Tests on Bituminous Mixes: Marshall mix design, Bitumen content determination using centrifuge extractor.

Text/Reference Books:

1. Highway Material Testing Laboratory Manual by Khanna S. K., Justo, C.E.G and Veeraraghavan, A., Nem Chand & Bros.
2. Various IRC, ASTM and AASTHO Codes

Subject Code: CE6L402	Subject Name: Fundamentals of Traffic Flow Theory	L-T-P: 3-1-0	Credit: 04

Pre-requisite(s): None

Driver behaviour, traffic information and control systems, traffic studies- volume, speed and delay studies, elements of traffic flow theory, PCU concept, characteristics of uninterrupted traffic, mathematical theories of traffic flow (Poisson arrivals, binomial and negative binomial distributions), headway distributions, gap acceptance, critical gap estimation, queuing theory, shock wave, capacity and LOS of Uninterrupted facilities, characteristics of interrupted traffic, traffic characteristics at unsignalised intersections, queue discharge characteristics at signalised intersections, dilemma zone.

Text/Reference Books:

1. Fred. L. Mannering, Walter P. Kilareski and Scott S. Washburn, Principles of Highway Engineering and Traffic Analysis, John Wiley & Sons.
2. D. R. Drew, Traffic Flow Theory and Control, MaGraw-Hill Book Company.
3. A. D. May, Traffic Flow Fundamentals, Prentice Hall.
4. Mike Slinn, Peter Guest and Paul Mathews, (2012). Traffic Engineering design, Taylor & Francis.
5. Roess and McShane, Roger P. Roess, Elena S. Prassas, William R. McShane, Traffic Engineering, Pearson.
6. L. R. Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers.
7. Louis J. Pignatro, Traffic Engineering-Theory and Practice, Prentice-Hall, Englewood Cliffs, New Jersey.
8. Khisty & Lal, Transportation Engineering, Prentice Hall India.
9. C. S. Papacostas and P. D. Prevedouros, Transportation Engineering & Planning.

Subject Code: CE 6L404	Subject Name: Analysis and Design of Pavements	L-T-P: 3-1-0	Credit: 04

Pre-requisite(s): None

Types of Pavements, Pavement Composition, Philosophy of design of flexible, composite and rigid pavements, analysis of pavements using different analytical methods, selection of pavement design input parameters, traffic loading and volume, material characterization, drainage, failure criteria, reliability, design of flexible, composite and rigid pavements using different methods (IRC, AASHTO, Austroads etc), comparison of different pavement design approaches, design of overlays.

Text/Reference Books:

1. Y. H. Huang, Pavement Analysis and Design, Pearson Education.
2. E.J. Yoder and M. W. Witczak, Principles of Pavement Design, McGrawPub.
3. Rajib B. Mallick, Tahar El-Korchi, Pavement Engineering: Principles and Practice, Second Edition, CRC Press
4. Animesh Das, Analysis of Pavement Structures, CRC Press
5. Nick Thom, Principles of Pavement Engineering, ICE Publishing

*The examination for this course may be considered for open book examination

system.

Subject Code: CE6P402	Subject Name: Traffic Engineering Studies	L-T-P: 0-0-3	Credit: 02

Pre-requisite(s): None

Volume studies: Direction, Duration and Classification of Traffic Volume at Mid-Block Section and Intersections, Headway Distributions

Speed studies: Spot Speed Studies

Journey time and delay studies: Travel Time and Delay Studies by Floating Car Method

Arrival pattern studies of vehicles, Queue discharge characteristics

Gap acceptance studies: Study of Gaps, Lags, Critical Gaps

Intersection delay studies: Delay Measurement at Intersections

Highway Capacity Estimation: Videographic method, Dynamic PCU

Text/Reference Books:

1. Currin, T. R. (2013). Traffic Engineering-A Manual for Data Collection and Analysis, 2nd Edition, Cenage Learning.
2. Slinn, M. Guest, P., Mattehews, P. (2006). raffic Engineering Design-Principles and Practice, 2nd Edition Elseiver.
3. Highway Capacity Manual, 2010
4. Relevant Indian Roads Congress (IRC) Codes

Subject Code: CE6P404	Subject Name: Transportation Systems Planning Studio	L-T-P: 0-0-3	Credit: 02

Pre-requisite(s): None

Application of probability and statistics in transportation data analysis; OD study; travel behaviour data processing and its analysis; Econometric/ Statistical model (parametric and non-parametric) development for travel demand analysis; computational analysis of transport network; logit model and its application in mode/route choice behaviour; estimating value of planning attribute; planning for parking spaces; urban/sub-urban road safety audit.

Text/Reference Books:

1. Simon P. Washington, Matthew G. Karlaftis, Fred L. Mannering, Statistical and Econometric Methods for Transportation Data Analysis, CRC Press
2. Relevant Indian Roads Congress (IRC) Codes
3. Williumsen and Ortuzar, Modelling Transport

Subject Code: CE6L451	Subject Name: Design of Transportation Facilities and Safety	L-T-P: 3-1-0	Credit:04

Pre-requisite(s): None

Geometric design provisions for various transportation facilities, Discussion of controls governing geometric design, Route layout and selection, Elements of design - sight distances, horizontal alignment, transition curves, super elevation and side friction. Vertical alignment: - grades, crest and sag curves. Highway cross-sectional elements and their design for rural highways, urban streets and hill roads. At-grade Inter-sections - sight distance consideration and principles of design, channelisation, mini round-abouts, layout and design of round-abouts, Design of signalised intersections, capacity and LOS for signalised intersections, signal design, signal coordination, interchange design templates, entrance and exit ramps, acceleration and deceleration lanes, Bicycle and Pedestrian Facility Design; Parking Layout and Design; Terminal Layout and Design. Accident prevention through better planning, Designing for safety, Highway operation and accident counter measures, Road safety checklists, accident data analysis and its prediction models.

Text/Reference Books:

1. A policy on geometric design of highways and streets, American Association of State Highway Officials.
2. Geometric design standards for urban roads in plains (IRC:86-1983), The Indian Roads Congress.
3. Geometric design standards for rural (non-urban) highways (IRC:73-1980), The Indian Roads Congress, 1980.
4. Manual of specifications & standards for six laning of highway through public private partnership (IRC: SP: 87-2010), The Indian Roads Congress.
5. Manual of specifications & standards for four laning of highway through public private partnership (IRC:SP:84-2009), The Indian Roads Congress.
6. Hill road manual (IRC:SP:48-1998), The Indian Roads Congress.
7. Guidelines for expressways – Part I, Ministry of Road Transport & Highways.
8. Guidelines for the design of interchanges in urban areas (IRC:92-1985), The Indian Roads Congress.
9. Roadside design guide, American Association of State Highway Officials.
10. Manual of geometric design standards for Canadian roads, Transportation Associations of Canada.
11. Pline, J.L., Traffic Engineering Handbook, Institute of Transportation Engineers.
12. Manual on Uniform Traffic Control Devices, Federal Highway Administration.
13. Highway Capacity Manual 2010, Transportation Research Board.
14. S.K. Khanna and C.E.G. Justo, Highway Engineering, Khanna Publishers, Roorkee, MXRoad Suite and manual for geometric design

Subject Code: CE6L452	**Subject Name: Economic Evaluation of Transportation System**	**L-T-P: 3-0-0**	**Credit:03**

Pre-requisite(s): None

concept of demand and its elasticity, concept of supply-side in transport, demand-supply interaction; appraisal and economic evaluation of transportation projects, Travel demand and value of time, Willingness-to-pay, Willingness-to-accept; valuation of user's benefit and transport pricing policy, economic evaluation of highway projects in India; Road-users' cost study in India-Objectives and Methodology, Using behavioural data for evaluation of transport infrastructure; stated and revealed preference data, binary and multinomial logit, maximum likelihood, case studies on choice modelling and estimation of value of planning attribute, multi-criteria analysis and public Policy.

Text/Reference Books:

1. Studies in the economics of transportation by Beckmann et al.
2. Applied Transport Economics by Stuart Cole
3. McCarthy, P. Transportation Economics, Blackwell Publishers
4. Transportation Decision Making: Principles of Project Evaluation and Programming, Wiley, by Kumares C. Sinha, Samuel Labi,
5. C. Jotin Khisty, B. Kent Lall, Transportation Engineering: An Introduction, Prentice Hall.
6. Indian Roads Congress, "Manual for Road Investment Decision Model", Special Publication 38, New Delhi.
7. Indian Roads Congress, "Manual on Economic Analysis of Highway Projects", Special Publication 30, New Delhi. Revised version.
8. John Hibbs, Transport Economics & Policy: A Practical Analysis of Performance, Efficiency and Marketing Objectives Kogan Page,.
9. Economics of Urban Transport by Kenneth A Small and Erik T Verhoef
10. Principles of Traffic and Highway Engineering by Garber and Hoel
11. Economic Evaluation of highway projects in India-IRC
12. Road Users cost study in India - IRC

Subject Code: CE6L453	Subject Name: Analysis of Transportation Systems	L-T-P: 3-0-0	Credit:03

Pre-requisite(s): None

Transportation Demand-Supply Concept & their Interaction, Concept of Traffic Analysis Zone, OD Matrix, evaluation process of transportation systems, Fundamentals of Travel Demand Forecasting model.

Urban form & structure, hierarchy of road Infrastructure, Components of transport Infrastructure, Roles of PPP model in transport infrastructure planning and management.

Accessibility, operations and evaluation of transport network services; concept & role of public transport, Para-Public Transport; Non-motorised transport and Micro-mobility; concept of multi-modal integration; SPV in management of transport services; Planning and evaluation of Bi-Cycle and Pedestrian infrastructure, Auditing of transport infrastructure/facility.

Basics of Urban Goods & Commodity Movement. Concept of Intelligent Transportation System (ITS) & evaluation of its application, concepts of temporal demand management using ITS tool.

Inclusivity and concept of universal design, guidelines for best practices; interactions of demographic and environmental factors with transport system. Assessment of security & Safety for all, Concept & need for marketing in transportation

Law & Legislation in Transport System Analysis such as National Urban Transport Policy, 2006 & 2014, Metro Rail Policy, 2017; Issues and Policy relating to Battery-Operated Vehicles (BOV), Transit Oriented Development, 2016; National Electric Mobility Mission Plan, Transport component in Smart City Mission Transformation.

Textbooks:

- Papacostas, C.S. and Prevedouros, P.D., 2015. *Transportation Engineering and Planning*. Pearson India Education Services Pvt. Ltd.
- Kadiyali, L.R., 2013. *Traffic Engineering and Transport Planning*. Khanna publishers.
- Chakroborty, P., Das, A., *Principle of Transportation Engineering*, Prentice Hall of India Pvt. Ltd.
- Tyagi, A.K. and Sreenath, N., 2023. *Intelligent Transportation Systems: Theory and Practice*. Springer.
- Vuchic, V.R., 2007. *Urban Transit Systems and Technology*. John Wiley & Sons.
- Garber, N.J. and Hoel, L.A., 2014. *Traffic and Highway Engineering*. Cengage Learning.
- Relevant Code Books of Indian Roads Congress.

Reference Books/Study Materials:

- Marvin L. Manheim, *Fundamentals Of Transportation Systems Analysis*, Volume 1
- Ennio Cascetta, *Transportation Systems Engineering*: Theory and Methods
- B.G. Hutchinson, *Principles of Urban Transport Planning* Hardcover – 1 January 1974.
- Adib Kanafani, 1983. *Transportation Demand Analysis*, McGraw Hill Higher Education.
- Ortuzar, J.D., and Williumsen, L. G., 2011. *Modelling Transport*. John Wiley & Sons.
- Manual and Demonstration of Software Packages on Travel Demand Forecasting CUBE, VISUM
- MoUD, 2015a. Atal Mission for Rejuvenation and Urban Transformation:

Mission Statement and Guidelines, Ministry of Urban Development, Government of India.

- MoUD, 2015b. Smart City Mission Transform Nation: Mission Statement and Guidelines, Ministry of Urban Development, Government of India.

Unified Traffic and Transportation Infrastructure (Planning & Engineering) Centre (UTTIPEC), Pedestrian Design Guidelines: "Don't drive…walk", 2009, Delhi Development Authority, New Delhi.

Subject Code: CE6L454	**Subject Name Pavement Evaluation and Management**	**L-T-P: 3-1-0**	**Credit:04**

Pre-requisite(s): None

Types of pavements, Distresses in flexible and rigid pavements , Techniques for functional and structural evaluation of pavements, pavement rehabilitation techniques, overlay design procedures, recycling of flexible and rigid pavements, Maintenance of paved and unpaved roads, Pavement management systems, Introduction to HDM-4

Text/Reference Books:

1. Y. H. Huang, Pavement Analysis and Design, Second ed.,Pearson Education
2. Rajib B. Mallick, Tahar El-Korchi, Pavement Engineering: Principles and Practice, Second Edition, CRC Press
3. Derek Pearson, Deterioration and Maintenance of Pavements, ICE Publishing
4. Ralph Haas, W. Ronald Hudson, John P. Zaniewski, Modern pavement management Modern Pavement Management, Krieger Pub Co
5. Croney, D. and P. Croney, The design and performance of road pavements, McGraw-Hill Book Company, London, UK.

Subject Code: CE6L455	**Subject Name Airport Planning and Design**	**L-T-P: 3-0-0**	**Credit:03**

Pre-requisite(s): None

Air transport and its characteristics, Capacity and configuration, Runway and Taxi way design, Design, maintenance and rehabilitation of airfield pavements, terminal area lay-out, air traffic control, Grading and drainage, Environmental guidelines for airport projects, air-traffic demand estimation.

Text/Reference Books:

1. Khanna,S. K., Arora A. K. and Jain S. S., Airport Planning and Design, Nem Chand & Bros.
2. Ashford, N. and Wright, P.H., Airport Engineering, Third ed, John Wiley & Sons
3. Robert Horonjeff, Francis X. McKelvey, William J. Sproule and Seth B. Young, Planning and Design of Airports, Fifth Ed., McGraw Hill Pub.

Subject Code: CE6L456	**Subject Name Public Transportation System**	**L-T-P: 3-0-0**	**Credit:03**

Pre-requisite(s): None

Urban Passenger Transport Modes Classifications, Role of Mass Transportation System, Transit Modes and Characteristics, System Performance, Capacity, Quality of Service, efficiency and utilization, trip makers' perception analysis to various travel attributes, Willingness-to-pay estimation, demand analysis and user's benefit policy issue with reference to public transportation service improvement, optimal transport pricing policy, planning Issues, Route Determination, Network Design, Service Policy and Schedule development, Life Cycle cost in public transportation, Scheduling, Priority Measures and their Implementations, Issues and Challenges related to development of Mass Transportation System, Para-transits.

Text/Reference Books:

1. Public Transit Planning and Operation: Theory, Modelling and Practice by Avishai Ceder

2. Urban Transit Systems and Technology by Vukan R. Vuchik.
3. Urban Transit: Operations, Planning and Economics by Vukan R. Vuchik
4. Studies in the economics of transportation by Beckmann et al.
5. Applied choice analysis: A Primer by David Hensher and Willium Greeene
6. Transportation Decision Making: Principles of Project Evaluation and Programming, Wiley,2007 by Kumares C. Sinha, Samuel Labi
7. Fundamentals of Transportation Engineering by Fricker and Whitford
8. Public Transportation related analysis using software like TRANSCAD, CUBE Software