GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Civil Engineering
Subject Code: BE05006031
Subject Name: Transportation Engineering

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Core Course

Prerequisite:	-
Rationale:	This course is designed to provide a fundamental understanding of transportation systems, including road, rail, water, and air transport, to the undergraduate engineering students. It covers essential concepts such as transportation planning, highway systems, traffic engineering, materials, construction practices, and maintenance, along with basic features of railway, harbour, and airport infrastructure. The course also introduces students to drainage, safety, and operational aspects, as well as key organizations governing the transportation sector. It equips students with the foundational knowledge required to analyse and understand transportation systems for safe, efficient, and sustainable mobility.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	To apply highway planning, alignment, and geometric design principles with a basic understanding of traffic flow and intersections.	30
CO-2	To explain highway materials, pavement types, construction, and maintenance, including distresses and remedies,	30
CO-3	To implement principles of highway drainage, arboriculture, and lighting for safe, efficient road infrastructure.	10
CO-4	To describe railway alignment, permanent way and track components, and basic operations including points, signalling, and terminals.	15
CO-5	To outline fundamentals of water and air transport, including harbour and airport components, site selection, operations, and navigation features.	15

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	PBL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.

Content:

Sr. No.	Content	Total Hrs
1	**Introduction:** Importance of transportation, different modes of transportation, an overview of road, rail, air, and water transportation; a comparison of various modes of transportation, organizations and their functions, including the Central Road Research Institute (CRRI), Indian Roads Congress (IRC), Railway Board (RB), Inland Waterways Authority of India (IWAI), Airports Authority of India (AAI), International Civil Aviation Organization (ICAO), and Directorate General of Civil Aviation (DGCA).	02
2	**Highway Transportation:**	
(a)	**Introduction:** Highway planning and development in India, classification of rural and urban roads, highway alignment and surveys. **Geometric Design:** Importance, highway cross section elements, sight distances, design of horizontal alignment, design of vertical alignment. **Traffic Engineering:** Traffic characteristics, traffic flow parameters – volume, speed, density, control devices, types of intersections	11
(b)	**Highway Materials:** Components of highway pavement and materials used. **Soil:** Importance, desirable properties, index properties, compaction, strength evaluation tests. **Aggregates:** Functions, desirable properties, tests on road aggregates and quality control. **Bituminous binders:** Functions, desirable properties, tests on bitumen and quality control, bitumen emulsion functions and classification, **Bituminous Mix:** Desirable properties and requirements of bituminous mix design; introduction to the Marshall Mix Design Method. **Introduction of Flexible and Rigid pavement:** Pavement component functions, factors affecting pavement design, difference between flexible and rigid pavement. **Construction of Flexible and Rigid Pavement:** soil stabilization, construction of granular sub-base/drainage layer, construction of granular base course (WBM and WMM), construction of bituminous pavement layers (base course and surface course), including prime coat and tack coat, Components of cement concrete pavement and its functions, construction of cement concrete pavement, joints in cement concrete pavement-function and construction. **Pavement Maintenance:** Types of distresses, remedial measures, objective and classification of highway maintenance works.	18

(d)	**Highway Drainage:** Requirements of drainage systems, surface drainage systems, and subsurface drainage systems. **Road Arboriculture:** Objectives, patterns of tree planting, advantages of arboriculture. **Highway Lighting:** its importance, design factors, and lighting layout	**02**
3	**Rail Transportation:** Basic requirements of railway alignment, functions of the permanent way; types, components, functions of railway elements: gauge, rails, fittings, ballast, embankments, and subgrade; purpose of coning of wheels and superelevation; introduction to points and crossings, signaling and interlocking systems; classification and functions of yards, junctions, and terminals.	**04**
4	**Water Transportation:** Classification, components, site selection of harbours, definitions of harbour, port, structures and their functions including jetty, breakwater, wharf, dock, lock, quay, mole, and dolphin; mooring and dredging operations; natural phenomena affecting harbours, including tides, waves, wind, and currents; navigational aids such as lighthouses, lightships, and buoys.	**04**
5	**Air Transportation:** Classification of airports; airport master plan; site selection criteria; zoning laws and imaginary surfaces; components of aircraft; importance and purpose of wind rose diagrams, runway orientation; elements of airport layout, including taxiways, aprons, terminal buildings; markings, lighting of runways, taxiways, and aprons.	**04**
	TOTAL	**45**

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**20**	**20**	**20**	**20**	**10**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The course contributes to the following SDGs:

SDG 7	Supports affordable, clean energy through efficient planning and operations in air and water transport, reducing fuel use and promoting clean energy.
SDG 9	Focuses on scientific highway planning, alignment, and geometric design—the backbone of modern highways.

SDG 11	Emphasizes efficient drainage to prevent waterlogging and damage, roadside plantation to improve urban livability, and proper lighting for safe, accessible transport systems.
SDG 12	Promotes efficient material use and lifecycle thinking in pavement engineering.
SDG 13	Supports climate action through railway system components that enable efficient rail systems.

Reference Books:

1 Huang Y. H., Pavement Analysis and Design. Prentice Hall, Englewood Cliffs, New Jersey, USA, 1993, ISBN-0-13-655275-7
2 Yoder E. J. and Witczak M. W., Principles of Pavement Design, John Wiley and Sons, New York, 1975
3 Mannering F. L., Kilareski W. P. and S. S. Washburn, Principles of Highway Engineering and Traffic Analysis. Wiley India Pvt. Ltd., New Delhi.
4 Atkins H.N., Highway Construction and Maintenance, Soils, and Concretes, Reston Publishing company, Reston VA, 1983.
5 Watson J. P., Highway Construction and Maintenance, Longman Scientific and Technical, New York, 1989.
6 Dr. Sharma S. K., Principles, Practice and Design of Highway Engineering (Including Airports), S. Chand & Company Ltd.
7 Chakraborty Partho, Das Animesh, Principles of Transportation Engineering, PHI
8 Khanna S.K., Justo C.E.G., Highway Engineering, Nem Chand & Bros., Roorkee.
9 Bindra S.P., A course in Highway Engineering, Dhanpat Rai Publications
10 Kadiyali L. R. and Lal, N. B., Principles & Practice of Highway Engineering, Khanna Publishers, Delhi.
11 Khanna S. K., Arora M. G. and Jain S.S., Airport Planning and Design, Nem Chand and Bros.
12 IRC:58-2015, Guidelines for the Design of Plain Jointed Rigid Pavement for Highways
13 IRC:37-2018, Guidelines for the Design of Flexible Pavements,
14 IRC: SP:21-2009, Guidelines on landscaping and tree plantation
15 Specifications for Road and Bridges, Ministry of Road Transport & Highways (MoRTH)
16 Chandra Satish, Agarwal M.M., Railway Engineering, Oxford University Press,
17 Rangwala S. C., Principles of Railway Engineering., Charotar publication
18 Bindra S. P., Docks & Harbour Engineering, Dhanpatrai Sons publication.
19 Srinivasan R., Harbour, Dock and Tunnel Engineering, Charotar Publication,
20 Linzodef Quinn A., Design and Construction of Ports & Marine structures, Mcgraw hill publication
21 Norman J. Ashford, Saleh Mumayiz, Paul H. Wright, Airport Engineering, Wiley publication
22 Saxena Subhash C, Airport Engineering Planning and Design, CBS Publishers & Distributors
23 Rangwala S. C., Airport Engineering, Charotar publication

List of Experiments:

1 Determination of aggregate crushing Value
2 Determination of aggregate impact value
3 Determination of Los Angeles Abrasion value

4 Determination of shape tests on aggregates.
5 Determination of Specific Gravity of aggregates.
6 Determination of California Bearing Ratio values
7 Determination of Penetration grade of bitumen.
8 Determination of softening point of bitumen
9 Determination of ductility of the bitumen
10 Determination of flash point and fire point of bitumen
11 Determination of Bitumen content
12 Determination of stripping value of road aggregate

Assignments based on:

1. Design of road geometric elements, including horizontal and vertical alignment, sight distance, and superelevation.
2. Assignment on basic elements of railway track and operations
3. Assignment on fundamentals of harbour planning and infrastructure
4. Assignment on fundamentals of airport planning, layout, and operations

Major Equipment:

1. Aggregate crushing value test apparatus
2. Aggregate impact value test apparatus
3. Los Angeles abrasion value test apparatus
4. Flakiness and Elongation index gauge
5. California bearing ratio test apparatus
6. Standard penetrometer for bitumen.
7. Ring and ball test apparatus
8. Ductility test apparatus
9. Flash and fire point test apparatus
10. Bitumen Extractor apparatus.

List of Open-Source learning website:

1. http://www.nptel.iitm.ac.in/courses/
2. https://onlinecourses.nptel.ac.in/noc25_ce60/preview
3. https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr25_ed58

Field Visit:

1. A site visit to highway construction project to gain practical understanding of construction procedures.
2. A site visit to a railway station to gain practical understanding of track components and operations.

List of suggested activities for Term Work / Self Learning:

Sr. No.	PBL Category	Name of the Activity	No. of Hours	Evaluation Criteria
1	Industry / Research Laboratory Visit	**Industry Visit** – Visit of highway construction site / pavement construction / traffic intersection analysis	Visit = 5h, Report = 5h → **Total = 10h**	Report should include observations on pavement layers, materials, geometric

				design, traffic flow, and calculations
2	Video Based Learning	**Technical Video-Based Learning** – Videos on highway geometric design, pavement construction, traffic studies, railway track components, airport planning	Video = 5h, Report = 5h → **Total = 10h**	Report/Presentation based on understanding of concepts like sight distance, pavement layers, traffic studies
		Self-learning Online Course – Course related to highway engineering / traffic engineering / airport planning (e.g., NPTEL)	Video = 5h, Report = 5h → Total = **10h**	Certificate + assessment performance in quiz/exam
		Safety Learning Videos – Safety measures in highway construction, railway operations, airport safety, traffic management	Video = 5h, Report = 5h → **Total = 10h**	Based on report/quiz highlighting safety practices and regulations
3	Assignment/ Technical Writing/ Research Writing	**Assignment Writing** – Numerical problems on pavement design, traffic flow parameters, railway track design	5 assignments × 2h → **Total = 10h**	Based on correctness, method, and presentation of solutions
4	Micro project	**Problem Solving / Software Application** – Use of Excel / Python / any software for traffic analysis, pavement design calculations	5h	Evaluation based on accuracy, logic, and application of engineering concepts
5	Complex Problem-Solving targeting relevant SDGs. / Mini Project	**Complex Problem Solving** – Real-life issues like traffic congestion, pavement failure analysis, drainage issues	Max 2 problems → **Total = 10h**	Depth of analysis, feasibility of solution, technical approach
6	Poster/ Chart/ Power point presentation	**Poster / Chart / PPT** – Topics like pavement types, traffic signs, airport layout, harbour components	**6h**	Creativity, technical accuracy, and presentation
7	Research Paper Review / Analysis	Discussion on research paper based on relevant subject (SCOPUS Index/any reputed Journal)	5 research paper = 20 hrs	Summarize research paper and evaluation critical parameters
8	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5hrs Report preparation = 5hrs Total = 10hrs	Based on in-depth study, technical depth, data collected, fact finding, etc.

9	Group Discussion / Quiz / Simulation	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 hrs each	Based on performance in group discussion, technical depth, knowledge etc.
10	Other	Patent Search and Innovation Gap Identification	10hrs (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

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