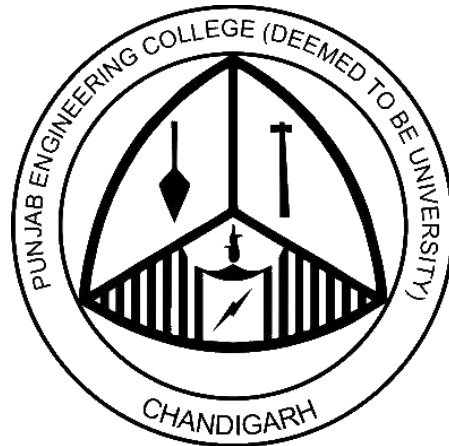


PG-Curriculum
(Structure and Course Contents)

Transportation Engineering
with effect from 2022-23 session



Civil Engineering Department
Punjab Engineering College
(Deemed to be University)
Chandigarh

Semester wise PG TRANSPORTATION ENGINEERING Scheme to be implemented w.e.f. 2022-23 session

SEMESTER-I		
S. No.	Courses (Course Code)	Credits
1.	Engineering Mathematics (EMR1001)	3
2.	Advanced Traffic Engineering (PCC-I) (TRR1101)	3
3.	Highway Construction Material and Methods (PCC-II) (TRR1102)	3
4.	Bridge Engineering (PCC-III) (TRR1103)	3
5.	(PEC-I) <ul style="list-style-type: none"> ● Airport Planning & Design (TRR1201) ● Reinforced Soil Design & Construction (TRR1202) ● Transportation Economics & Finance (TRR1203) ● Advanced Foundation Engineering (TRR1204) 	3
6.	Soft-Computing (SCR1001)/ Soft Skills & Management (SMR1001)	3
Total		18

SEMESTER-II		
S. No.	Courses	Credits
1.	Transportation System Planning & Management (PCC-IV) (TRR1104)	3
2.	Pavement Analysis & Design (PCC-V) (TRR1105)	3
3.	Intelligent Transportation Systems (PCC-VI) (TRR1106)	3
4.	(PEC-II) <ul style="list-style-type: none"> ● Railway Infrastructure Planning & Design (TRR1251) ● Sustainable Transportation Systems (TRR1252) ● Road Safety Engineering and Auditing (TRR1253) ● Application of GIS in Transportation Engineering (TRR1254) ● Management of Transportation Projects & BOT Schemes (TRR1255) 	3
5.	(Open Elective-I) <ul style="list-style-type: none"> ● Road Safety & Management (TRR3001) ● Transportation & Environment (TRR3002) 	3
6.	Industrial Tour (TRR4001)	0
7.	Design of Experiments and Research Methodology (TRR1001)	3
Total		18

SEMESTER-III		
S. No.	Courses	Credits
1.	Seminar and Report Writing (TRR5001)	2
2.	Research Publication Ethics (TRR6001)	2
3.	Dissertation – I (TRR7001)	14
Total		18

SEMESTER-IV		
S. No.	Courses	Credits
1.	Dissertation – II (TRR8001)	18
Total		18

Total Credits = 18 + 18 + 18 + 18 = 72

Note: *Industrial Tour will be held in winter vacation after 1st semester and it will be recorded in 2nd Semester.

**In the first and second semester, at least one of the Department Core Courses should have laboratory component.

SEMESTER - I

Course Name	:	Advanced Traffic Engineering
Course Code	:	TRR 1101
Credits	:	3
LTP	:	2-0-2

Total No. of Lectures: 28
Total No. Lab Hours: 28

Course Objectives:		BL
The main objectives of the course are		
1.	To get acquainted with traffic characteristic, modelling approaches, traffic flow model and their applications.	3
2.	To be able to design and analyze the facilities so as to control and manage traffic.	6
3.	To familiarize with tools and techniques of traffic management and their applications.	4
4.	To develop basic understanding of the different statistical methods and evaluate their significance in traffic engineering	5

Course Content:

S. No.	Course Contents	No.of Lectures
1.	Traffic Characteristics and Traffic studies: Introduction to Traffic Engineering, Traffic characteristics, Traffic studies: Volume, Speed, Origin and destination, Parking, Accidents, Lighting, Capacity, Level-of-service.	6
2.	Traffic Control devices: Various Traffic Control devices, Principles of Intersection Design, Design of signalized, un-signalized intersections, signal coordination	5
3.	Statistical methods for Traffic Engineering: Need, Elementary concepts of Probability, Mean, Standard Deviation and Variance, Poisson and Binomial Distribution, Normal Distribution, Sampling Theory and Significance Testing, Linear Regression and Correlation, Multiple Linear Regression	5
4.	Traffic Flow Theory: Fundamentals of Traffic flow theory, Macroscopic and Microscopic Traffic flow models, Shockwave Analysis, Car following theory, Queuing Theory, Vehicle arrival, Gap and Gap acceptance	6
5.	Traffic Management: Fundamentals of Traffic Management, Principles and Methodology, Traffic Systems Management, Technique of management, Exclusive Bus Lanes Traffic Management Techniques, Speed control and Zoning, Parking Control, Traffic Segregation and Channelization, Principles and Design of Traffic Signs, Their Placement and Visibility, Transportation System Management, Route and Network Management, Area Traffic Management, City wide Traffic Control and Management, Centralized Data Processing and Monitoring.	6

Lab Work:

S.No	Lab contents	No. of Hours
1.	Evaluation of the level of service at an urban intersection	6
2.	Check the traffic volumes of an urban stretch and determine whether an additional lane is required or not.	4
3.	Evaluate the signs on a road stretch and check their viability with IRC codes.	4
4.	Studies on safety performance under mixed traffic	6
5.	Compute the impact of bicycles on the traffic flow	4
6.	Assessment of Parking demand of an urban area	4

Course Outcomes:

At the end of this course the students will be able to:	
1.	Efficiently conduct traffic surveys and use the Traffic survey analysis for management of traffic, designing existing and new road infrastructure
2.	Develop ability to design various types of intersections, Implementation of Traffic Control devices and traffic regulations
3.	Gain confidence in studying Applications of Traffic flow theories to solve congestion problems and to use simulation techniques.

References:

S. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1.	Traffic Engineering and Transport Planning, Kadiyali, L. R., Khanna Publishers	2011
2.	“HighwayEngineering”, 10 th Edition, Khanna S.K., Justo C.E.G. and Veeraragavan A., Nem Chand and Bros. Roorkee	2015
3.	“Transport Planning and Traffic Engineering”, Butterworth Heinemann, O’Flaherty C A, Elsevier, Burlington, MA	2006
4.	Principles of Traffic Engineering and Traffic Analysis, Third Edition, Mannering Fred L., Kilarski Walter P. and Washburn Scott S., Wiley	2007
5.	Traffic Engineering, 4th Edition, Roess, R. P., Prassas, E. S., and McShane, W. R., Prentice Hall	2010
6.	Principles of Transportation Engineering, ChakrobortyPartha and Animesh Das, Prentice hall	2005

e-Learning Resources:

- <https://archive.nptel.ac.in/courses/105/105/105105215/>

Course Name	:	Highway Construction Materials and Methods
Course Code	:	TRR 1102
Credits	:	3
LTP	:	2-0-2

Total No. of Lectures: 28

Total No. Lab Hours: 28

Course Objectives:		BL
The main objectives of the course are		
1.	To get acquainted with quality assurance, and economic selection of pavement materials.	3
2.	To be able to perform all the necessary lab tests required to be done on highway construction materials.	4
3.	To familiarize the fundamentals of mix design and carry out mix design.	6
4.	To study and evaluate the applications of the recent trends in the field of highway construction materials.	5

Course Content:

No.	Course Contents	Lectures
1.	Sub-grade Soil Characterization: Properties of sub-grade layers; different types of soils, Mechanical response of soil; Soil Classification; Index and other basic properties of soil; A critical look at the different laboratory and in -situ procedures for evaluating the mechanical properties of soils viz. SPT, DCPT, CPT, CBR, Plate Load test & resilient modulus; Suitability of different type of soil for the construction of highway embankments and pavement layers; Field compaction and control. Dynamic properties of soil: FWD test.	4
2.	Introduction to Soil Stabilization: Physical and Chemical modification: Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen. Grouting: Categories of grouting, Art of grouting, Grout materials, Grouting techniques and control. Introduction to Ground improvement techniques; Introduction to Geo textiles and synthetics applications.	4
3.	Aggregate Characterization: Desirable characteristics of Road aggregates, proportioning of aggregates, Artificial aggregates, Sustainability and availability of sound aggregates	4
4.	Bitumen and Bituminous Concrete Mix Characterization: Bitumen sources and manufacturing, Chemistry of bitumen, bitumen structure, Rheology of bitumen, Elastic modulus, Dynamic modulus, visco-elastic and fatigue properties, creep test, Resilient, Diametral Resilient and Complex (Dynamic) Moduli of Bituminous Mixes.	4
5.	Modified bitumen and Design of Bituminous mix: Crumb Rubber Modified bitumen, Natural rubber modified bitumen, polymer modified bitumen; Introduction to emulsified bitumen and its characterization; Long term and short-term ageing and its effect on bitumen performance, Tests to simulate ageing of bitumen viz. RTFOT and PAV. Desirable properties of bituminous mixes, Design of bituminous mixes: Modified Marshall's specifications, Bituminous Road construction Procedure	4

6.	Cement Concrete Pavement: Types of cements and basic cement properties, Special cements; Quality tests on cement; Tests on cement concrete including compressive strength, flexural strength, modulus of elasticity and fatigue properties; Introduction to advanced concretes like self-compacted concrete, Light weight concrete, Roller Compacted Concrete for pavement application; IS method of cement concrete mix design with case studies; Role of different admixtures in cement concrete performance; Joint fillers for Jointed Plain Cement Concrete Pavements and their characterization; Nano technology applications in cement concrete, Concrete road construction.	8
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Lab Work:

S. No.	Lab contents	No. of Hours
1.	Proportioning of soil, proportioning of aggregates	4
2.	Characterization of aggregates	4
3.	Characterization of bitumen	4
4.	Testing of Bituminous mix	4
5.	Testing of pavement grade concrete	4
6.	Presentation on pavement construction equipment and methods	4
7.	Presentation on Quality assurance in pavement construction	4

Course Outcomes:

At the end of this course the students will be able to:	
1.	Examine the properties of the highway materials and perform Bituminous Mix Design
2.	Determine the suitability of the concrete and bituminous mixes in compliance to codal provisions.
3.	Reduce cost with minimum adverse impact on environment

References:

S. No.	Name of Book/ Authors/Publishers	Year of Publication/Re print
1.	Principles of Transportation engineering by Chakroborty & Das, Prentice Hall, India	2009
2.	Highway Engg by S.K Khanna & CEG Justo, Nem Chand Bros., Roorkee	2001
3.	Principles and practices of Highway engg by L.R Kadyali, Khanna Publishers, Delhi. Edition 6	2013

e-Learning Resources:

- <https://archive.nptel.ac.in/courses/105/105/105105107/>

Course Name	:	Bridge Engineering
Course Code	:	TRR 1103
Credits	:	3
LTP	:	3-0-0

Total No. of Lectures: 42

Course Objectives:

The main objectives of the course are:		BL
1	To introduce the basics of bridge hydrology and economic considerations and get acquainted with relevant IRC codes used in bridge engineering.	4
2	To familiarize with the types, suitability, selection, design criteria of various types of bridges.	3
3	To be able to carry out the Analysis and evaluation of various types of bridges and their construction using different methods.	5
4	To be able to design different types of bridges.	6

Course Contents:

S. No.	Course Contents	No. of Lectures
1	General Bridge systems: Considerations in alignment, Planning, Economic considerations, Aesthetics and selection of type of bridge, Bridge Hydrology, Scour Depth, Depth of foundation, Estimation of Design Discharge	5
2	Loading Standards: Specifications for loading, geometrical proportioning etc. Road, Rail-cum-Road bridges, Indian Road Congress and Indian Railway loading standards and their comparison with loading standards followed in U.K., U.S.A. and Europe.	3
3	Design of Bridges: Reinforced Concrete Bridges, Slab culverts, T-Beam Bridges, Box Girder Bridges	12
4	Bridge Bearings	4
5	Design of sub structure - Piers and Abutments.	6
6	Design considerations for pre-stressed bridges, trussed steel	6
7	Limit State concept for Design of RCC bridges.	6

Course Outcomes:

At the end of the course the students will be able to:	
1.	Design sub-structures -piers and abutments.
2.	Carry out design of Highway Bridges
3.	Examine the existing bridges

References:

S. No.	Name of Book/ Authors/Publishers	Year of Publication/ Reprint
1	Bridge Superstructure, N. Rajagopalan, Narosa Publishing House	2006
2	Bridge Engineering Handbook, W. F. Chen and L. Duan, CRC press	2003
3	Structural Bearings, H. Eggert and W. Kauschke, Ernst & Sohn	2002
4	Design of Bridges, N. Krishna Raju, Oxford and IBH Publications	1988
5	Victor D.J, Essential of Bridge Engineering Oxford & I.B.H. Publishing Co., New Delhi.	2001

e-Learning Resources:

- https://onlinecourses.nptel.ac.in/noc22_ce63/preview

Course Name	:	Airport Planning & Design
Course Code	:	TRR 1201
Credits	:	3
LTP	:	3-0-0

Total No. Lectures: 42

Course Objectives:		BL
The main objectives of the course are		
1.	To get acquainted with the fundamentals of airport planning, demand forecasting, geometrics of the airfield and carry out its analysis.	4
2.	To be able to plan and perform geometric design of airfields and terminals.	6
3.	To acknowledge and evaluate the importance of air traffic management and familiarize with different air traffic management systems	5
4.	To develop the understanding of various air travel demand forecasting and their application.	3

Course Content:

S. No.	Course Contents	No. of Lectures
1.	Aircraft Characteristics: Aircraft characteristics related to airport design - Landing gear configurations, aircraft weight, engine types. Atmospheric conditions affecting aircraft performance: air pressure, temperature, wind speed and direction. Aircraft performance characteristics: speed, payload and range, runway performance, declared distances, wingtip vortices.	7
2.	Airport planning and air travel demand forecasting: Airport system planning Hierarchy of Planning - Airport Master Plan - Elements of Airport Master Plan - Airport Layout Plan - Forecasting methods: time series method, market share method, econometric modelling. Facilities requirements – Design alternatives - Financial plans- Land use planning – Environmental planning - Air Transport Planning in India – Airport Site Selection	7
3.	Geometric Design of the Airfield: Airport classification - Principles of Airport Layout -Airfield Configuration - Runway Orientation - Obstructions to Airspace - Runway Length-Runway and Taxiway Cross Section - Longitudinal-Grade Design for Runways and Stop- ways - Longitudinal-Grade Design for Taxiways -Taxiway Design - exit taxiway - Capacity - Level of Service - Airside Capacity - Factors Affecting Airside Capacity and Delay - Determination of Runway Capacity and Delay - Annual Service Volume – Calculating Aircraft Delay - Taxiway and Gate Capacity	8
4.	Planning and Design of the Terminal Area: Components of airport terminal - Function of Airport Passenger and Cargo Terminal - Facilities Required at Passenger Terminal – Design considerations: terminal demand parameters, facility classification, level of service criteria. Terminal planning process: overall space requirements, concept development, horizontal distribution concepts, vertical distribution concepts. Passenger and Baggage Flow – Apron gate system: number of gates, ramp charts, gate size, aircraft parking type, apron layout, apron circulation, passenger conveyance to aircraft, apron utility requirements Design of Air Freight Terminals - Airport access - Airport Landside planning – Capacity	8

5.	Air Traffic Management: Navigational aids: ground-based systems, satellite based systems – Air traffic control and surveillance facilities – Weather reporting facilities - Requirements of visual aids, Air field lighting - approach lighting system configurations, visual approach slope aids, threshold lighting - Runway lighting, taxiway lighting. Runway and taxiway marking, airfield signage - Air traffic separation rules: vertical separation, flight altitudes, longitudinal separation, and lateral separation – future enhancements to air traffic management.	8
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Course Outcomes:

Upon completion of this course, the students should be able to:	
1.	Apply the concept of airport planning and demand forecasting
2.	Design the runways, taxiways and aprons
3.	Design the components of airport terminal

References:

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1.	Airport planning and Design, Sixth Edition, Khanna, S. K., Arora, M. G., and Jain, S. S. Nem Chand and Bros, Roorkee, India,	2012
2.	Airport Engineering Planning, Design, and Development of 21st century Airports, Norman J. Ashford, Saleh Mumayiz, Paul H. Wright; John Wiley & Sons, Inc.,	2011
3.	Planning and Design of Airports, Fifth Edition, Horonjeff, R., McKelvey, F. X., Sproule, W. J., and Young, S. B. McGraw-Hill, New York, USA	2010
4.	Airport Planning and Management, Sixth Edition, Young, S. B., and Wells, A. T. McGraw-Hill, New York, USA	2011
5.	Airport ground access mode choice models, Geoffrey D. Gosling; Transportation Research Board, Washington, D.C	2008

e-Learning Resources:

- <https://archive.nptel.ac.in/courses/105/107/105107123/>

Course Name	:	Reinforced Soil Design and Construction
Course Code	:	TRR 1202
Credits	:	3
L – T – P	:	3 – 0 – 0

Total No. of Lectures: 42

Course Objectives (COs):		BL
At the end of the course, the students will be able to:		
CO1	To develop a basic understanding of characteristics of the different types of reinforcing material.	2
CO2	To be able to examine, evaluate and select appropriate reinforcement material as per desired requirements.	5
CO3	To be able to carry out the design of the structures using reinforced soil.	6
CO4	To get acquainted with the geosynthetics, its properties, application and usage in soil stabilization	4

BLOOM Taxonomy Levels (BL) –

1- Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating

Course Content:

S. No.	Description	No. of Lectures
1	INTRODUCTION Basic concept of the Reinforced soil, Mechanism Design principles, Materials used for Construction, Advantages of reinforced soil.	04
2	PRACTICAL APPLICATIONS Reinforced soil in Flyovers Bridges and other Civil Engineering structures, Basic components and strength characteristics of reinforced soil, Reinforced soil construction detailing.	06
3	GEOSYNTHETICS An overview of Geosynthetics, Description of Geotextiles, Geogrids, Geonets, Geomembranes, Geocomposites, Geocells- properties and test methods, Functions, Design methods for separation, stabilization, filtration, Drainage.	05
4	RETAINING WALLS Types of walls; Earth pressures for gravity/counterfort walls; structural design of wall and its foundation; stability of the wall-soil system; Slip circle analysis	04
5	REINFORCED SOIL WALLS Stability Analysis and construction aspects of Reinforced Soil Walls, Effect of reinforced sloped backfill on Soil wall design, Drainage design procedure.	06
6	WALL WITH REINFORCED BACKFILL Theoretical analysis, Pressure-Intensity on the wall, stability against sliding and overturning, Design procedure, Limitations of the analysis.	05
7	FOUNDATIONS ON REINFORCED SOIL Brief overview, Analysis of strip footing, isolated- square and rectangular footing on reinforced soil bed, Determination of Pressure Ratio.	06
8	SOIL NAILING AND ANCHORS Applications of Soil Nailing, Its components, Advantages and Limitations, Design aspects.	06

Course Outcome:	
1.	To make the students learn the concepts of reinforced soil and its applications in the Civil Engineering field.
2.	The students should be able to distinguish between different types and varied applications of geosynthetics
3.	Design the reinforced soil walls

Suggested Textbooks:	
<ul style="list-style-type: none"> ● “Designing with Geosynthetics,” Robert M. Koerner, Prentice Hall. (2012) ● “Engineering with Geosynthetics,” G.V Rao & GVS Suryanarayana Raju, Tata Mc Graw Hill Publishing Co. New Delhi. (1990) ● “Reinforced Soil and its Engineering Application,” Swami Saran, New Age Publication. (2006) 	

Suggested References:	
<ul style="list-style-type: none"> ● “Fundamentals of Geosynthetic Engineering,” Shukla, S.K. and Yin, J.H., Taylor & Francis. (2006) ● “Geotechnical Engineering,” Gulati, S.K. and Datta, M. Tata Mc Graw Hill Publishing Co. New Delhi. (2005) 	

e-Learning Resources:	
<ul style="list-style-type: none"> ● https://nptel.ac.in/courses/105/106/105106052/ NPTEL video course on Geosynthetics and Reinforced Soil Structures ● https://nptel.ac.in/courses/105/101/105101143/ NPTEL video course on Geosynthetics Engineering: Theory and Practices 	

Course Name	:	Transportation Economics and Finance
Course Code	:	TRR 1203
Credits	:	3
LTP	:	3-0-0

Total No. of Lectures: 42

Course Objectives:

The main objectives of the course are:		BL
1.	To gain an insight into road user cost, transportation cost, finance, taxation and economic evaluation of transportation projects.	5
2.	To acknowledge the economic functions of transportation systems.	3
3.	To be able to analyze and evaluate the operating costs of vehicles.	6
4.	To get acquainted with the concept of financing of highway projects and estimation of direct and indirect costs related to transportation.	3

Course Contents:

No.	Course Contents	Lectures
1.	Introductory Concepts in Transportation Decision Making: Overall transportation project development, budgeting, financial planning, the process of transportation project development, models associated with transportation impact evaluation	4
2.	Economic evaluation of transport projects: Need for economic evaluation, cost and benefits of transport projects, time horizon in economic assessment, basic principles of economic evaluation, interest rate, method of economic evaluation, benefit cost ratio method, first year rate of return, net present value method, internal rate of return method, comparison of methods of economic evaluation.	6
3.	Vehicle operating costs: Introduction, road user and cost study in India, components of VOC, factors affecting VOC, fuel consumption relationship, spare parts consumption, maintenance and repairs, labour, cost, tyre life, lubricants, utilization, and fixed costs.	4
4.	Economic analysis of projects :- Methods of evaluation - Cost-benefit ratio, first year rate of return, net present value, and internal-rate of return methods; Indirect costs and benefits of transport projects.	4
5.	Value of travel time savings: Introduction, classes of transport users enjoying travel time savings, methodology for monetary evaluation of passengers' travel time, review of work in India on passengers' travel time.	5
6.	Accident costs: Introduction, relevance of accident costing for a developing country, review of alternative methodologies for accident costing, Indian studies.	4
7.	Traffic congestion, traffic restraints and road pricing: Congestion as a factor in road traffic, traffic restraint, road pricing.	4

8.	Appraisal and Evaluation of Transportation Projects: Feasibility and evaluation, cost, impacts and performance levels, evaluation of alternatives, analysis techniques, cost-benefit analysis, social and financial benefits, valuation of time, measures of land value and consumer benefits from transportation projects, prioritization of projects, multi-criteria decision assessment.	6
9.	Highway finance: Methods for raising funds for maintenance, improvement and expansion of transportation networks, taxation and user fee, financing through loans, bonds, PPPs	5

Course Outcomes:

At the end of the course the students will be able to:	
1	Analyse transportation project case studies.
2	Evaluate transportation project case studies.
3	Perform analysis to determine vehicle operational cost, losses and expenditure cost of accidents.
4	Compare various methods for raising funds for a highway project and chose the most feasible and viable among them.

References: -

S. No.	Name of Book/ Authors/Publishers	Year of Publication/ Reprint
1.	Principles of Transportation engineering by Chakroborty& Das, Prentice Hall, India.	2009
2.	Highway Engg by S.K Khanna & CEG Justo, Nem Chand Bros., Roorkee	2001
3.	Principles and practices of Highway engg by L.R Kadyali, Khanna Publishers, Delhi. Edition 6	2013
4.	Principles of Transportation and Highway engg by G.V Rao, Tata Mc graw-Hill Publishing Co.Ltd. N.Delhi	1996
5.	HarralClell G., A Manual for the Economic Appraisal of Transport Projects, World Bank Report, Washington D.C	2006

e-Learning Resources:

- <https://nptel.ac.in/courses/105104098/45>

Course Name	:	Advanced Foundation Engineering
Course Code	:	TRR 1204
Credits	:	3
L T P	:	3-0-0

Total No. Lectures:- 42

Course Objectives:

The main objectives of the course are:		BL
1.	To study the different types of foundation and their suitability for particular site and structure., soil-structure interaction, calculation of allowable load and settlement of the foundation	3
2.	To be able to analyze and design shallow foundations and deep foundations.	6
3.	To get acquainted with the concept of soil liquefaction and its remedial measures	5

BLOOM Taxonomy Levels (BL) –

1- Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating

Course Contents:

S. No.	Course Contents:	No. of Lectures
1.	Shallow Foundations: Design considerations- factors of safety (including limit state), allowable settlements, location and depth of foundations, Codal provisions, Consolidation settlement in clays (with correction factors). Immediate settlement. Settlement in sands from N- values, elastic solutions. Static cone tests, Plate load tests.	12
2.	Deep foundations: Type of Piles. Construction methods. Axial capacity of single piles-static formulae, Skin friction and end bearing in sands and clays. Axial capacity of groups, Codal provisions. Laterally Loaded Piles: Short and long piles; Free head and fixed head piles; Lateral load capacity of single piles; Lateral deflection; Elastic analysis; Group effect; Lateral load test; Codal provisions. Caissons and Wells.	12
3.	Soil structure interaction: Introduction to soil-foundation interaction problems, soil behaviour, Foundation behaviour, Interface behaviour, Soil Foundation interaction analysis, Soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behaviour.	8
4.	Soil Liquefaction: Concept of soil liquefaction, effects of soil liquefaction , quick sand condition and remedial measures, stone column, vibrofloatation, deep compaction.	5
5.	Foundations in difficult soils: Expansive soils, chemically aggressive environment, soft soils, fills, regions of subsidence.	5

Course Outcomes:

At the completion of the course, students will be able to:	
1.	Decide the type of foundation required for a particular site and structure.
2.	Make geotechnical design of the foundations for civil engineering structures under varied field conditions.
3.	Carry out analysis to identify problems of liquefaction and ascertain remedial measure for soil improvement.

References:

S. No.	Name of Book/Authors/Publisher	Year of Publication/ Reprint
1.	Foundation Analysis and Design, Joseph E. Bowles, Mc-Graw Hill Publications	1997
2.	Design aids in soil mechanics and foundation engineering, Kaniraj S.K., Mc-Graw Hill Publications	1988
3.	Pile Foundation Analysis and Design, Poulos H.G. and Davis, E.H., John Wiley, 1980.	1980

e-Learning Resources:

- <https://nptel.ac.in/courses/105105039/>
- <https://freevideolectures.com/course/2674/foundation-engineering>

SEMESTER - II

Course Name	:	Transportation System Planning and Management
Course Code	:	TRR 1104
Credits	:	3
LTP	:	3-0-0

Total No. of Lectures: 42

Course Objectives:		BL
The main objectives of the course are:		
1	To familiarize with the techniques of analysis, performance evaluation and management of transportation systems	4
2	To acknowledge the various techniques related to estimation of transportation demand	5
3	To be able to conduct various traffic surveys in an urban area and get acquainted with various traffic control devices being used in transportation systems.	3
4	To examine various transportation planning techniques and their applications	5

No.	Course Contents	Lectures
1.	General Importance of transportation, transportation planning methodology, hierarchical levels of planning and its relation to rural, urban areas. Long range planning, Passenger and goods transportation, General concept and process of transport planning, Land-use transport interactions, Socio-economic characteristics of Land use	7
2.	Transportation and society Transportation and Society- Role of Transport in Society and Economy - Functions and Problems in Transportation Planning - Economic, Geographical, Political, Technological, Social and Cultural Factors in Planning of Transportation System. Transport Technology: System Classification and their Variation; Conventional Systems and Unconventional Systems - Air, Water and Ground Modes	7
3.	Transportation Systems Multi modal transportation system; Characteristics of Mass Transit systems including technical, demand operational and economic problems, Mass Rapid Transit System Elevated, Surface and Underground construction, Express Bus System, Operating Characteristics of Terminal and Transfer facilities	7
4.	Urban Transportation Planning Studies Urban Travel Characteristics, Transportation demand Surveys, Delineation of the urban area, zoning, Origin-Destination Studies, Home Interviews, trip Classification and Socio-Economic variables in trip making projections	7
5.	Planning Methodology and Systems Analysis Study of existing network-trip generation techniques, Category analysis, multiple regression techniques, Trip distribution techniques, Growth Factor model, Gravity models, Opportunity models and multiple regression models, Traffic assignment methods, Minimum Path Tree-All or nothing assignment	8
6.	Maintaining and Operating System: Operational Controls of Air, Water, Railway and Highway Transportation Systems: Functions of Control & Communications - Signals and Traffic Control Devices - Navigational Aids of the different Transportation Systems. Air Traffic Control; Navigational Control. Automatic Signaling Systems of Railway and Highway Movements.	6

Course Outcomes:

At the end of the course the students will be able to:	
1.	Gain Knowledge of various systems of transportation.
2.	Have an in-depth knowledge of Demand projection techniques of various transportation systems.
3.	To identify and analyse the impact of various factors that affect various aspects of urban transportation system

References:-

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1.	Traffic Engineering and Transport Planning,, Kadiyali L.R., Khanna Publishers	2011
2.	Highway Engg.- Khanna S.K.and Justo C. E.G. New Chand Publication	2008
3.	“Transport Planning and Traffic Engineering”,CAO’ Flaherty, Butterworth Heinemann, Elsevier, Burlington, MA	2006
4.	Transportation Engineering and Planning, by C.S. Papacostas and P. D.Prevedouros, Prentice Hall of India Private Limited	2001

e-Learning Resources:

<ul style="list-style-type: none">● https://nptel.ac.in/courses/105105208● https://nptel.ac.in/courses/105107067/

Course Name	:	Pavement Analysis & Design
Course Code	:	TRR 1105
Credits	:	03
LTP	:	3-0-0

Total No. of Lectures:- 42

Course Objectives:		BL
The main objectives of the course are		
1.	To familiarize with the fundamentals of analysis, design of pavement structure, maintenance of pavement, rehabilitation strategies and their applications	3
2.	To get acquainted with and carry out analysis of pavements and evaluate pavements based on various theories and concepts as per IRC codes such as IRC 37 and IRC 58	5
3.	To be able to carry out design of flexible and rigid pavements.	6
4.	To be able to design overlays and to understand pavement evaluation.	6

BLOOM Taxonomy Levels (BL) –

1- Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating

Course Content:

S. No.	Course Contents	No. of Lectures
1.	Fundamentals of pavement design: Requirements of an ideal pavement, elements of pavement structure and their function. Materials used in pavement construction: aggregates, Portland cement & concrete, asphalt and asphalt concrete. Types of pavement and comparison of flexible and rigid pavements, comparison of highway and airport pavements.	7
2.	Analysis and Design of Flexible pavements: Layered system concepts, Stress solution for one, two and three layered systems, Fundamental design concepts, Empirical, semi-empirical and theoretical approaches, Design of highway pavements by IRC Method, Application of Pavement Design Software.	10
3.	Analysis and Design of Rigid pavements: Westergaard's theory and assumptions, Stresses due to curling, Stresses and deflection due to loading, frictional stress. Stresses in dowel bars and tie bars, Types of joints and their functions, joint spacing, Design of CC pavement for roads, highway as per IRC, Design of joints.	10
4.	Rehabilitation and Maintenance of pavements: Factors affecting pavement design and performance, Causes of failures of flexible pavements and remedial measures, causes of failures of rigid pavements and remedial measures, maintenance of pavements.	5
5.	Pavement evaluation and overlay design: Introduction, method of pavement evaluation, design principles of overlay, IRC design guidelines.	10

Course Outcomes:

At the end of this course the students will be able to:	
1.	Carry out analysis and design of flexible pavements
2.	Carry out analysis and design of rigid pavements.
3.	Examine the existing pavements and recommend measures for the maintenance and Rehabilitation of Pavements.
4.	Have in depth knowledge of the pavement evaluation and design principles governing Overlay.

References:

S. No.	Name of Book/ Authors/Publishers	Year of Publication/ Reprint
1.	Principles and practices of Highway Engineering L.R. Kadyali& N.B Lal	2006
2.	“Principles, Practices and design of Highway Engineering”, Sharma S.K, S. Chand Publisher	2012
3.	“Highway Engineering”, 10 th Edition, Khanna S.K., Justo C.E.G. and Veeraragavan A., Nem Chand and Bros. Roorkee	2015
4.	Relevant IRC codes	
5.	“Highways : the Location, Design, Construction and Maintenance of Road Pavements”, 4th Ed., O’Flaherty, A. Coleman, Elsevier	2006

e-Learning Resources:

- <https://nptel.ac.in/courses/105104098>

Course Name	:	Intelligent Transportation Systems
Course Code	:	TRR 1106
Credits	:	03
LTP	:	2-0-2

Total No. of Lectures: 28

Total No. Lab Hours: 28

Course Objectives:		BL
The main objectives of the course are		
1.	To introduce fundamental concepts of ITS and its functional areas, get acquainted with different types of sensors and their applications	3
2.	To have an overview of ITS implementation in developed countries.	4
3.	Estimate traffic congestion by the acquisition of big data using advanced devices.	5
4.	To familiarize with various simulation techniques/software in the field of transportation engineering and their application	3

Course Content:

S. No.	Course Contents	No. of Lectures
1.	Introduction to Intelligent Transportation Systems (ITS) – Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.	8
2.	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).	8
3.	ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Emergency Management, Advanced Vehicle safety systems, Information Management.	8
4.	ITS Standards: ITS standards, development process, legal issues, financial issues, Mainstreaming ITS; integration and up-gradation; Future of ITS, case studies	4

Lab Work:

S. No.	Lab contents	No. of Hours
1.	Introduction and basic understanding of various softwares related to transportation.	4
2.	Introduction to PTV VISSIM and learning its basics.	12
3.	Simulation using PTV VISSIM to visualize traffic conditions at a Roundabout.	4
4.	Simulation using PTV VISSIM to visualize traffic conditions at a Conventional Intersection.	4
5.	Simulation using PTV VISSIM to visualize traffic conditions at a Staggered Intersection.	4

Course Outcomes:

At the end of this course the students will be able to:	
1.	Outline the need of ITS and illustrate role of communication systems in ITS
2.	Identify functional areas and services of ITS
3.	Apply the various ITS methodologies
4.	Simulate the various traffic conditions using VISSIM

References:

S. No.	Name of Book/ Authors/Publishers	Year of Publication/ Reprint
1.	Fundamentals of Intelligent Transportation Systems Planning Chowdhury, M. A., and Sadek, A., Artech House	2003
2.	Perspectives on Intelligent Transportation Systems (ITS) Sussman, J. M., , Springer	2005
3.	Turban, E., and Aronson, J. E., Decision Support Systems and Intelligent Systems, 5th Edition, Prentice Hall	2004

e-Learning Resources:

- <https://www.civil.iitb.ac.in/tvm/nptel/591 ITS 1/web/web.html>
- <https://www.civil.iitb.ac.in/tvm/nptel/592 ITS 2/web/web.html>

Course Name	:	Railway Infrastructure Planning & Design
Course Code	:	TRR 1251
Credits	:	3
LTP	:	3-0-0

Total No. of Lectures:- 42

Course Objectives:		BL
The main objectives of the course are		
1.	To have an over view of importance of railway, its infrastructure and analyze the travel behavior and plan for the railway line network.	4
2.	To design the geometry of the track system	6
3.	To get acquainted with the signaling, interlocking, maintenance and management of the railway track system	2
4.	To explore and evaluate the recent advancements in the field of railway and their applications	5

Course Content:

No.	Course Contents	Lectures
1.	Planning of Railway Lines: Railways operational system, historical background of Indian railways, plans and developments, policy and standards, traffic forecast and surveys, railway alignment, project appraisal, and organization setup.	4
2.	Components of Railway Track and Rolling Stock: Permanent way, forces acting, rails, rail fixtures and fastenings, sleepers and ballast, rail joints, elements of junctions and layouts, types of traction, locomotives and other rolling stock, brake systems, resistance due to friction, wave action, wind, gradient, curvature, starting, tractive effort of a locomotive, hauling power of a locomotive.	5
3.	Railway Track Geometric Design: Right of way and formation, field investigations, geometric design elements, safe speed on curves, speeds computation, string lining of curves, gradients, grade compensation, railway cant and cant deficiency, traction.	6
4.	Track Construction and Maintenance: Track laying, inspection and maintenance, maintenance tools, maintenance of rail surface, track drainage, track tolerances, mechanized method, ballast confinement and directed track maintenance, bridge maintenance, renewal, classification of renewal works, mechanized relaying, track renewal trains.	5
5.	Signaling and Interlocking: Objectives, classification, fixed signals, stop signals, signaling systems, mechanical signaling system, electrical signaling system, systems for controlling train movement, interlocking, modern signaling installations.	4
6.	Railway Accidents and Safety: Train accidents, collision, derailments, causes, restoration of traffic, safety measures, disaster management, classification of level crossings, accidents at level crossings, remedial measures, maintenance of level crossings.	6
7.	Railway Station and Yards: Site selection, facilities, classification, platforms, building areas, types of yards, catch sidings, slip sidings, foot over bridges, subways, cranes, weighbridge, loading gauge, end loading amps, locomotive sheds, triangles, traverser, carriage washing platforms, buffer stop, scotch block, derailing switch, sand hump, fouling mark.	6

8.	High-Speed Railways: Modernization of railways, the effect of high-speed track, vehicle performance on the track, railway track design for high speeds, dedicated freight corridors, high-speed ground transportation system, ballast less track, elevated railways, underground and tube railways.	6
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Course Outcomes

At the end of this course the students will be able to:	
1.	Plan the railway network.
2.	Determine factors governing the design of railway infrastructure.
3.	Design the railway track system and identify a suitable signal system and develop maintenance strategies.
4.	Assess requirements of high-speed railway track and recommend suitable measures for the safety of the railway network.

References:

S. No.	Name of Book/ Authors/Publishers	Year of Publication/ Reprint
1.	Railway Engineering, Chandra, S., and Agarwal, M.M., Oxford University Press, Noida, India, Second Edition	2013
2.	Railway Track Engineering, Mundrey, J.S., McGraw-Hill Education Private Limited, New Delhi, India, 2017, Fifth Edition.	2017
3.	A Textbook of Railway Engineering , Saxena, S.C., and Arora, S.P., Dhanpat Rai Publications, New Delhi, India, , Eighth Edition.	2017
4.	Indian Railway Track , Agarwal, M.M., Prabha & Co., New Delhi, India, Twentieth Edition	2018
5.	Railway Engineering, Gupta, B.L., and Gupta, A., Standard Publishers Distributors, New Delhi, India, Third Edition	2012
6.	Railway Engineering, Rangwala, S.C., Charotar Publishing House Pvt. Ltd., Anand, India, Twenty Seventh Edition.	2017

e-Learning Resources:

- <https://nptel.ac.in/courses/105107123>
- <https://archive.nptel.ac.in/courses/105/107/105107123/>

Course Name	:	Sustainable Transportation Systems
Course Code	:	TRR 1252
Credits	:	3
LTP	:	3-0-0

Total No. of Lectures:- 42

Course Objectives:		BL
The main objectives of the course are		
1.	To examine the sustainability of transportation systems by determining environmental issues, their characteristic, scale of the problem related to transportation systems.	4
2.	To evaluate the challenges of potential solutions in order to reduce unsustainable impacts of the transport	5
3.	To study the concept of Environmental Impact Assessment and different planning processes related to sustainability in transportation.	3
4.	To familiarize with different modes of sustainable transportation	5

BLOOM Taxonomy Levels (BL) –

1- Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating

Course Content:

S. No.	Course Contents	No. of Lectures
1.	Introduction to Transportation systems: Evolution of Transportation modes, Transportation Systems, Factors influencing Development & Efficiency of a Transport System, Components of Transportation System, Multimodal Transport, Concept of Sustainability, Current Scenario of Transportation in India, Climate change: Indicators and impacts	5
2.	Impacts of Transportation Systems-I: Transport-Environmental Link, Energy consumption and Emissions by Transport Sector, Environmental Impacts of Transport, Traffic generated Air Pollution (The Case of Los Angeles, California), Policy implication, Health Improvement Strategies, Case Study, Mitigation Measures, Conclusion	5
3.	Impacts of Transportation Systems-II :- Noise, Harmful Effects of Noise, Noise Level Standards, Factors affecting Traffic Noise, Sources of Vehicular Noise, Noise measurements, Mitigation measures for Noise pollution, Numerical Problems.	5
4.	Introduction to Environmental Impact Assessment(EIA): EIA processes, Methodologies of EIA, Global practices in EIA process EIA Process in India, Case Study	4
5.	Introduction of Land Use:- Land use planning & zoning, Transit Oriented Development(TOD), TOD implementation, TOD case study – Section of Delhi Metro	5
6.	Introduction to Sustainable Transport Planning: Traditional Planning Process, Contemporary Planning Process, Management Strategies, Life Cycle Assessment (LCA), LCA Case study, Material Flow Analysis (MFA), Concept of Circular economy in Transport Sector, Initiatives & Policies for Environmental Sustainability, National Clean Air programme & Transport Sector	6
7.	Alternative Fuels and Sustainable Transportation: Non-Motorized Transport(NMT), Electric vehicles, Emerging Transport Technology – Hyperloop, Case Study- Bus Rapid Transit System (BRTS), Mass Rapid Transit Systems(MRT)	6
8.	Sustainability Indicators:- Sustainable Transport Appraisal Rating (STAR), Measuring Sustainability, Material Flow Analysis Tool- STAN	6

Course Outcomes:

At the end of this course the students will be able to:	
1.	Explain the unsustainable impacts of today's transport sector
2.	Analyze and compare the potentials and challenges of technological, organizational and policy solutions
3.	To find optimum solutions and propose a plan towards sustainable transportation

References:

S. No.	Name of Book/ Authors/Publishers	Year of Publication/ Reprint
1.	Assessment & Decision Making for Sustainable Transport, European Conference of Ministers of Transport, OECD Publishing.	2004
2.	Wood, C. and Wood, C., "Environmental Impact Assessment: A Comparative Review", Prentice Hall.	2002
3.	Petts, J., "Handbook of Environmental Impact Assessment", Blackwell Publishing.	1999
4.	Sucharov, L.J. and Baldasano, J.M., "Urban Transport and the Environment, Vol. II", Computational Mechanics Publications.	1996
5.	Zannetti P. (Ed.), "Environmental Modeling, Vol. I", Computational Mechanics Publication, Elsevier Applied Science.	1993

e-Learning Resources:

- <https://nptel.ac.in/courses/105107210>

Course Name	:	Road Safety Engineering and Auditing
Course Code	:	TRR 1253
Credits	:	3
LTP	:	3-0-0

Total No. of Lectures:- 42

Course Objectives:		BL
The main objectives of the course are		
1.	To introduce the fundamentals of road safety and road safety audit	2
2.	To get familiarized with various road safety techniques, measures and their applications	3
3.	To be able to analyze and evaluate various road safety measures	5
4.	To decipher, examine and analyze the road accident data and various mitigation measures.	4

BLOOM Taxonomy Levels (BL) –

1- Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating

Course Content:

S. No.	Course Contents	No. of Lectures
1.	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.	4
2.	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	9
3.	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.	7
4.	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.	5
5.	Crash Reconstruction: Describe the basic information that can be obtained from the roadway surface, Basic physics related to crash reconstruction, speed for various skid, friction, drag, and acceleration scenarios, variables involved in jump and flip crashes, variables involved in pedestrian crashes, Case Studies	8
6.	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.	9

Course Outcomes:

At the end of this course the students will be able to:	
1.	Analyze the effect of user, roadway, and environment characteristics on traffic
2.	Plan and design of road safety improvement programs.
3.	Interpret accident data using statistical analysis and evolve safety measures using accident data.
4.	Conduct road safety audit.

References:

S. No.	Name of Book/ Authors/Publishers	Year of Publication/ Reprint
1.	Airport ground access mode choice models , Geoffrey D. Gosling; Transportation Research Board, Washington, D.C.	2008
2.	Airport Engineering Planning, Design, and Development of 21st century Airports, Norman J. Ashford, Saleh Mumayiz, Paul H. Wright; John Wiley & Sons, Inc.	2011
3.	Planning and Design of Airports, Fifth Edition, Horonjeff, R., McKelvey, F. X., Sproule, W. J., and Young, S. B. McGraw-Hill, New York, USA	2010
4.	Airport Planning and Management, Sixth Edition, Young, S. B., and Wells, A. T. McGraw-Hill, New York, USA,	2011
5.	Airport planning and Design, Sixth Edition, Khanna, S. K., Arora, M. G., and Jain, S. S. Nem Chand and Bros, Roorkee, India.,	2012

e-Learning Resources:

- https://www.civil.iitb.ac.in/tvm/nptel/582_Accident/web/web.html
- <https://nptel.ac.in/courses/105105215>

Course Name	:	Remote Sensing & GIS for Engineers
Course Code	:	TRR 1254
L - T - P	:	3 - 0 - 0
Credits	:	3

COURSE OBJECTIVES:		BL
1.	Expose the students to the concept of digital mapping, to make them aware of recent advancements/software in surveying like Remote sensing, digital photogrammetry, GIS, DIP etc.	3
2.	To familiarize with map projections and working with co-ordinate systems	4
3.	To get acquainted with data analysis of vector based and raster based data	5

Course Content:

Lecture Wise Breakup of the Syllabus:	No. Of Lectures
MODERN TRENDS IN SURVEYING AND MAPPING: Digital Mapping, Uses and applications, data collection techniques (Conventional and Non-conventional), Present Status in India and abroad	4
AERIAL PHOTOGRAMMETRY Introduction, types, Stereoscopy, Scale of a photograph, flight planning, Mosaics	3
GEOGRAPHICAL INFORMATION SYSTEM (GIS) Introduction, advantages, objectives of GIS, Definitions of GIS, Components of GIS, Overlay analysis, Digital Terrain Modelling, Digital Elevation Model Applications of GIS in various engineering fields, Four M's, Elements of Image visualization	5
INTRODUCTION TO REMOTE SENSING (RS) Introduction, EM spectrum, Ideal RS System, Real RS System, Visual Image interpretation, active and passive remote sensing, Reflectance; spectral reflectance of land covers; Spectral characteristics of solar radiation; energy interaction in atmosphere; energy interactions with Earth's surface, Spectral reflectance curves, Resolution	6
DIGITAL IMAGE PROCESSING (DIP) Introduction, Histogram and image statistics, Remote Sensing Image distortion and rectification: Radiometric errors and Geometric errors. Image Enhancement Techniques, Image classification – Supervised and Unsupervised classification, Formats	6
GLOBAL POSITIONING SYSTEM Introduction, GPS, DGPS, Applications	5
SMART CITY & GEOSPATIAL TECHNOLOGY Introduction, Applications of GIS/RS in a smart city.	3
Software demonstrations and working GIS/RS software	10

COURSE OUTCOMES (COs):	
At the end of the course, the students will be able to:	
CO1	Apply the concepts and analytical methods related to surveying
CO2	Use the various surveying equipment
CO3	Plan and execute surveying projects
CO4	Prepare a map and concepts of 3-D view
CO5	Identify the potential use of Remote Sensing and GIS in Civil Engineering

SUGGESTED BOOKS:

1)	Geomatics Engineering, Manoj Arora and R C Barjatiya, Nem Chand Brothers, Roorkee.
2)	Principles of GIS, Peter A. Burrough, Rachael A., Oxford University Press
3)	Remote Sensing and Image Interpretation, Lillesand and Kiefer, Wiley Publishers
4)	Introduction to GIS, Kang-tsung, Tata McGraw Hill, 5th Edition
5)	Surveying Vol. I & II, B.C. Punmia, A.K. Jain & Jain. Luxmi Publications (P) Ltd., New Delhi.

SUGGESTED REFERENCES:

	Year of Publication
“Surveying Vol. II”, S.K.Duggal: Tata McGraw Hill, New Delhi.	2009
“Surveying and Levelling,” Subramanian, Oxford university press.	2012
“Surveying and Levelling,” N NBasak, McGraw Hill.	2014
“Surveying Vol II & III,” K.R. Arora, Standard Book House, New Delhi.	2010

e-Learning Resources:

https://nptel.ac.in/courses/105/104/105104101/ NPTEL video course on Surveying
https://nptel.ac.in/courses/105/107/105107122/ NPTEL web course on Surveying

Course Name	:	Management of Transport Infrastructure Projects & BOT Schemes
Course Code	:	TRR 1255
Credits	:	3
LTP	:	3-0-0

Total No. of Lectures: - 42

Course Objectives:

The main objectives of the course are:-		BL
1.	To understand risks in management of various Transportation Infrastructure projects	4
2.	To explore opportunities in management of various Transportation Infrastructure projects.	3
3.	To understand the BOT Schemes in project management.	6
4.	To understand the various insurance policies required in construction projects.	5

S. No.	Course Contents	No. of Lectures
1.	Construction Project Management: An Overview- Construction industry; construction project; product development process; project management ; main causes of project failure; BOT, BOOT, BORT and other variants of BOT. causes of introducing this system, Liberalization policies of GOI for these system; GOI, state governments, other local bodies, board, corporation etc. are adopting these system for construction project management.	4
2	Project Management Information System: PMIS concept; PMIS framework; information system computerization; user's system specifications development; acquiring a system; problems in information system management; benefits of computerized information system	3
3	Risk management in infrastructure projects: Introduction; identification of risks: an important principle, task involvement, aspects to analyse; Stages of project implementation: gestation stage, development stage, construction stage, operational stage, termination stage; Specific categories of risk: revenue risk, design risk, construction risk, operating risk, financial risk, political risk, legal risk, environmental risk, force majeure risk.; allocation & management of risks: concept of risk management, management of risk, risk matrix.; Developers perspective of risk; Government's perspective of risk.	6
4	Management in Construction: Overview; Risk Management process: when to use, procedure of providing Advice; Risk Management Responsibility: risk manager, risk owner, team approach; Stages of risk Management: stages , assessment, management, typical sequence, identification classification, direct/ indirect costs, risk matrix, quantification; Response: hold, avoid, reduce, transfer, share, review.; conclusion.	5
5	Management Process: Introduction; risk identification; brainstorming: interviews, The Delphi Technique, expert systems.; Qualitative Assessment: classification and reference, description of risk, risk trigger, relationship to other risk, potential impact, likelihood of occurrence, response.; Mitigation: meaning, avoidance, risk avoidance risk transfer, residual or retained risk. Risk analyse: meaning, a brief introduction to stastics, method of risk assessment.	5
6	Tools and techniques of risk management: Introduction; qualitative methods: risk register, risk estimate, simple arithmetic analysis, MERA, decision trees, sensitivity analysis, influence diagrams, probability analysis, computer software; conclusion.	5

7	Technical procedure for management: Introduction; phases of construction: the design phase, construction phase; post construction; risk matrix; exhibits	3
8	Construction Project Insurance: Introduction; insurance policy structure; types of insurance mentioned in the model; guidance on insurance for construction projects; current conditions of contract; general services provided by the project insurance companies	3
9	Construction Project Insurance policies: Introduction; storage cum erection and marine cum erection insurance, subject matter, insured party, cover ,sum insured, period of cover, deductible franchise, basis of claim settlement, extension of basic cover, risk distributor, marine cum erection.; contractor's all risk policy: introduction, scope of cover, main exclusions, sum assured , period of contract, basis of settlement of claims, various extensions of the policy, escalation, maintenance, claims procedure and documents, documents required.	8

Course Outcomes:

At the end of course the students will be able to:

1	Carry out a complete knowledge of Construction Project Management Including the risk involved in the construction project
2	Classify and quantify the risk associated with the construction project in Highways.
3	Understand the BOT schemes applied in construction project management.

Reference Books:

S No.	Name of Book/Authors/Publishers	Year
1	Indian highways –a framework for commercialization by Gajendra Haldia	2010
2	Risk management in construction projects NCP-center of distance Education for construction industry manager	2016
3	NHAI & CIDC websites withsomenationalandinternationaljournalsofconstructionfieldwiththeproceedingsofconferences/seminarsorganized by CIDC&NICMAR	2014
4	Construction Project Management by Col. K.K Chitkara Published by Tata McGraw Hill	2017

e-Learning Resources:

- <https://nicmar.ac.in/>
- <https://nptel.ac.in/courses/105103093>

Course Name	:	Road Safety & Management
Course Code	:	TRR 3001
Credits	:	3
LTP	:	3-0-0

Total No. of Lectures: 42

Course Objectives:		BL
The main objectives of the course are		
1.	To understand the causes of accidents, statistical measures of accident data analysis and computer application in data analysis.	3
2.	To examine and evaluate different parameters responsible for providing road safety in the construction of new roads.	5
3	To familiarize with concept of road reconstruction principle, improvement of road considering the different components of road and intersections, road safety and maintenance measures.	3
4	To learn about road safety audit principle and procedure, various traffic management techniques and their effectiveness.	2

BLOOM Taxonomy Levels (BL) –

1- Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating

Course Content:

No.	Course Contents	Lectures
1.	Road accidents, Causes, Scientific Investigations and Data Collection:- Analysis of Individual Accidents to Arrive at Real Causes; Statistical Methods of Analysis of Accident Data, Application of Computer Analysis of Accident Data.	4
2.	Ensuring Traffic Safety in Designing New Roads:- Ways of Ensuring Traffic Safety in Road Design considering the Features of Vehicle Fleet, Psychological Features of Drivers, Natural and Meteorological Conditions, Structure of Traffic Streams, Orientation of a Driver on the Direction of a Road beyond the Limits of Actual Visibility and Roadway Cross Section & Objects.	10
3.	Ensuring Traffic Safety in Road Reconstruction:- Road Reconstruction and Traffic Safety, Reconstruction Principles, Plotting of Speed Diagram for Working out Reconstruction Projects, Use of Accident Data in Planning Reconstruction of Roads, Examples of Reconstruction of Selected Road Sections for Improving Traffic Safety, Improving Traffic Conditions on Grades, Sharp Curves, Redesign of Intersections, Channelized At-Grade Intersections, Bus Stops, Parking & Rest Areas and Effectiveness of Minor Road Improvements.	10
4.	Ensuring Traffic Safety in Road Operation:- Ensuring Traffic Safety during Repair and Maintenance, Prevention of Slipperiness and Influence of Pavement Smoothness, Restriction speeds on Roads, Safety of Pedestrians, Cycle Paths, Informing Drivers on Road Conditions with Aid of Signs, Traffic Control Lines & Guide Posts, Guardrails & Barriers and Road Lighting	10
5.	Road Safety Practices: - Principles- Procedures and Practice, Code of Good Practice and Checklists. Road Safety Issues and Various Measures through Engineering, education and enforcement measures for improving road safety	8

Course Outcomes:

At the end of the course the students will be able to:	
1.	Able to acquire knowledge statistical methods and computer application of accident analysis.
2.	Capable of analyzing the factors affecting the construction of new roads, reconstruction of existing road and operational conditions of road.
3.	Able to remember the process of road safety audit and the measures of improving road safety. .
4.	Qualified to evaluate the effectiveness of various management techniques adopted in reducing road accident..

References:-

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1.	`Traffic Engineering and Transport Planning', Kadiyali, L.R., Khanna Publications, New Delhi	2009
2.	“Transportation Engineering- An Introduction”, Thrid Edition, C. JotinKishty& B. Kent Lall, Prentice Hall of India Private Limited, New Delhi	2006
3.	‘Text book of Highway Engineering’, Khanna and Justo, Nemchand Brothers, Roorkee	2001
4.	Latest Editions of Relevant Indian Roads Congress (IRC) Publications for Design of Roads and Road Safety	
5.	‘Road conditions and Traffic Safety’, BABKOV, V.F. MIR, publications, Mascow	1975
6.	‘Safer Roads – A Guide to Road Safety Engg.’, K.W. Ogden, Averbury Technical, Ashgate Publishing Ltd., Aldershot, England	1996

e-Learning Resources:

- https://www.civil.iitb.ac.in/tvm/nptel/582_Accident/web/web.html
- <https://nptel.ac.in/courses/105105215>

Course Name	:	Transportation & Environment
Course Code	:	TRR 3002
Credits	:	3
LTP	:	3-0-0

Total No. of Lectures:- 42

Course Objectives:		BL
The main objectives of the course are		
1.	To study the relation between transportation and environment and the effect of increasing transportation demand on land use	4
2.	To analyze and evaluate the direct and indirect effects of transportation sector on environment	5
3.	To get acquainted with various policies of Governmental organizations	2

BLOOM Taxonomy Levels (BL) –

1- Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating

Course Content:

S. No.	Course Contents	No. of Lectures
1.	Environmental effects of transport: Problems of identification; Environmental Impact Assessment: Evaluation of environmental impact due to construction. of new facilities and the effect of traffic thereon due to Bypasses, widening/four laning, expressway; grade separators. Assessment and attenuation.	12
2.	Assessment of Environmental impacts of Transportation:- Noise; vibration; air pollution; Air pollution. emission levels, air- pollution dispersion, The box model, noise generation, noise measurement, noise propagation and mitigation strategies, noise measures, mathematical models of transportation noise, energy consumption and related issues. Environmental traffic management. Co-ordinated signal system on urban arterial road intersections to reduce air pollution.	12
3.	Pedestrian delay and danger: severance; accidents; Visual intrusion and aesthetics; Toxic freight; construction effects.	6
4.	Land consumption and land-use effects:- planning blight and compensation; Global climate, energy and resource use; and sustainability, GoI policies and requirements for clearances for Road projects.	6
5.	Emergency care, Institutions and management of traffic safety, Education, training, policing, penalties, Risk perception, probability, indices and Indicators	6

Course Outcomes:

At the end of this course the students will be able to:	
1.	Learn about measures for controlling pollution for various transportation systems.
2.	To be aware of various environmental regulations.
3.	Carry out EIA of an existing transportation facility and suggest required modifications to minimize the overall impact.

References:

S. No.	Name of Book/ Authors/Publishers	Year of Publication/ Reprint
1.	The Art of Regression Modeling in Road Safety,Hauer, E, Springer, 2015	2015
2.	The Way Forward: Transportation Planning and Road Safety. Tiwari, G., Mohan, D. and Muhlrads, N.(eds) New Delhi: Macmillan India Ltd., 2005.	2005
3.	Transport, Climate Change and the City, Robin Hickman and David Banister. Routledge, London, 2014	2014
4.	Human Factors in Traffic Safety, Paul Olson and Robert Dewar (2007) Amazon Digital.	2007
5.	World Report on Road Traffic Injury Prevention, Peden, M., et al. World Health Organization, Geneva, 2004.	2004

e-Learning Resources:

- <https://transportgeography.org/contents/chapter4/transportation-and-environment/>
- https://www.teachengineering.org/lessons/view/cub_intro_lesson02

Course Name	:	Design of Experiments and Research Methodology
Course Code	:	TRR1001
Credits	:	3
L T P	:	3 0 0

Course Objectives

The main Objectives of this course are:	
1	To introduce the fundamentals of Statistical techniques, Sampling techniques, and Data Collection and the interpretation to the students.
2	To make the students understand the concept of research, need for research, types of research and steps in conducting research.

Total Nos. of Lectures: 42

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Introduction: Principles of design of experiment, Methodology for design of experiment, Screening design, Factorial design, Randomized design.	3
2	Sample & Estimation: Population, Sample, Probability in sampling, sampling with replacement, parameters of samples.	3
3	Probability and random variables: Bayesian probability, conditional probability, Bayes theorem, statistical independence of events, random variables- discrete and continuous, probability distribution functions, cumulative distribution functions, Expectation and variance of a random variable, joint distribution of two random variables and their correlation.	6
4	Statistics for Engineers: Discrete & Continuous distributions, different distributions functions application in engineering, distribution estimation & its assessment.	6
5	Simulation: Monte Carlo method, Queuing theory, Markovian process.	3
6	Random Variables Data Analysis: Single and multi- variables data analysis, estimation of parameters, spline smoothing, residual analysis, ANOVA.	6
7	Modelling: Introduction to modelling, types of models, development of mathematical models	3
8	Geostatistics: Introduction to Geostatistics, Geostatistical data analysis methods.	4
9	Stochastic Processes: Time series analysis, model identification, forecast and uncertainty analysis.	4
10	Research Report Writing: Purpose and nature of research, Research ethics Research proposal and literature review, Defining the problem, Finding and managing information, Developing and stating hypotheses. Research report, writing a thesis, writing for publication.	4

Course Outcomes:

At the completion of this course, students will be able to:	
1	Make use of various Research methodologies and its applications in the relevant field of engineering.
2	Organize and conduct research in a more appropriate manner.

Bibliography:

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Probability and Statistics for Engineers and scientists, Walpole, Myers, MyersandYe, Pearson Education.	7th edition, 2002
2	Statistics in Research, Bernand Ostleand Richard N. Mensing, Oxford & IBH Pub Co.	3 rd edition, 1975
3	Probability and Statistics in Engineering, Hines, Montgomery, Gold sman and Borrer, John Wiley & Sons.	4th edition, 2003
4	Experimental design, Theory & application, Federer, Oxford & IBH pub Co.	1955
5	Introduction to probability & statistics for Engineers and scientists, Sheldon M. Ross Elsevier Academic press, California, USA	2014

MOOCs on this course are available at:

1. <http://professional.mit.edu/programs/short-programs/design-and-analysis-experiments>
By Prof. Paul Berger, MIT Professional Education
2. <https://nptel.ac.in/courses/107108011/>
By Prof. Amaresh Chakraborty, Indian Institute of Science, Bangalore