Structure of Post Graduate (M.E. Transportation Engineering)

THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
PATIALA, PUNJAB, INDIA

THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

CURRICULUM & SCHEME OF COURSES

ME-Transportation

Engineering

Civil Engineering Department

2024

Curriculum Development – Guiding Principles

The statutory bodies of the institute, the Senate or the Planning and Monitoring Board oversee the design and development process so that the activity is carried out in a planned manner. The detailed planning for this activity is the responsibility of the Department Head. The systematic process of design and development includes the activities & sub activities including techniques & organizational interfaces and the time frame for completion of various activities. The plans are updated, as the instructional design evolves.

The design and development process generally begins with a need analysis report which comprises of (i) Stated needs (ii) Implied needs (iii) Overall goals of Instructions (iv) Relevant standards i.e. AICTE and UGC guidelines and Curricula of Entrance Tests like Indian Engineering Services (IES) and Graduate Aptitude Test for Engineers (GATE), etc. and
(v) General characteristics of target population.

Organizational and Technical interfaces between different faculty and external expert groups providing input to the instructional design are defined, committees are constituted and their reports are documented. Faculty members from different disciplines connected with the design & development activity are associated with the process. The updation/restructuring is carried outas the design process progresses. Clear responsibilities are assigned and effective communicationis ensured.

The requirements of instructional design are determined and recorded. For instructional design, the input is taken from various sources. Input requirements are clearly understood and reconciled. The design input may come from:

- Need analysis & Reviews.
- Recommendations from
  - Faculty & senior management
  - Employers and industry
  - Alumni
  - Regulatory Bodies
- Success/failure reports of similar courses & programs.
- Published literature relevant to programs.
- Boundary condition w.r.t GATE, IES, IAS curricula etc.

The general steps followed in curriculum development are as under:

- The need for starting a new programme or course(s) may arise from interaction with Industry, Faculty, Students, Alumni or PMB/Senate/BOG, UGC/AICTE etc.
- The idea of proposed programme is discussed in the HODs' meeting and if found appropriate, the Head of concerned department is asked to put up a proper proposal. A sub-committee of internal/external member(s) may sometimes be formed for making the feasibility and viability analysis.
- The DAAC (on the basis of recommendations of sub-committee, wherever required) does the need analysis and prepares the proposal for approval from Board of Studies (BOS).

- The BOS after deliberating on the proposal may make the desired modifications and then send the proposal to DOAA for consideration in SUGC/SPGC, along with the duly filled checklists.
- The proposal is put up for consideration to SUGC/SPGC and upon its approval the recommendations may be sent to the Senate and PMB.
- After the Senate approval, the proposal may be sent to concerned Department/School through academic section for allocation of appropriate course codes OR if required it is sent to AICTE/UGC for approval and the status is put up in the forthcoming meeting of BOG.
- Once approved, it is implemented by the concerned Department/School after allocation of proper course code by the academic section.

The employability, innovation and research in curriculum design and development is ensured by:

- Involvement of industry professionals in curriculum development
- Benchmarking exercises to extract customers (employer's) requirements
- Mandatory project semester in Industry for all UG and some PG students
- Synergizing curriculum with industry practices and needs

The curriculum design and development for all programs is done at least once every four years to ensure continuing suitability, adequacy and effectiveness in satisfying the requirements and the vision, mission and quality policy of the institute. The design process includes assessing opportunities for improvement and the need for ensuring suitable employability, innovation and research (more applicable to postgraduate programs). The process invites formal inputs from all stake holders and generally includes the following sources:

- Action taken report on the previous reviews and external accreditation reports (NAAC, NBA-AICTE)
- Results of student's performance in various examinations
- Result of Students Reaction Survey
- Feedback from
  - Industry,
  - Alumni,
  - Participating organizations in campus placement and other concerned sources
- Details of corrective/preventive actions
- Improvement programs suggested/recommended
- Training programs launched
- Review of mission and quality policy

The process of determining solutions to satisfy the identified needs is laid down and documented. Instructions are designed by incorporating these solutions. The analysis and mappings are recorded. The design output at this stage is taken as the initial design forsubsequent reviews. The output of instructional design & development is documented in theform of a report named "Curriculum and Scheme of Courses". Through various reviews and verifications, it is ensured that the design output meets the design input requirements.

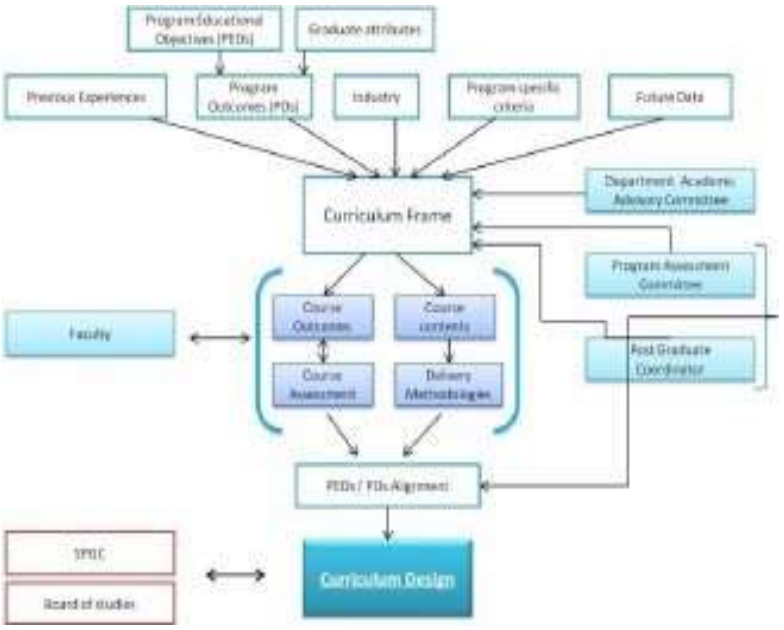
The design output report includes:

- The types and levels of skill and knowledge to be imparted
- Program Educational Objectives; Student Outcomes
- Course Outcomes
- Scheme of courses and the detailed syllabi
- Assessment and evaluation.

The output documents like curriculum and instructional strategies are reviewed and approved before release at various levels and stages.

Reviews are conducted at defined stages of the curriculum design, in which faculty members from the concerned area as well as experts from amongst the peer group from within and/or outside the institute are associated. Records of the reviews are maintained. Based on the reviews, the curriculum is updated.

New/revised curriculum and instructional design is made applicable to the prospective students. The curriculum is validated in the initial stages of its introduction by taking a feedback from students and faculty members regarding the effectiveness and applicability of the curriculum, with regard to the documented needs. Necessary changes, if required, are made to ensure that the design conforms to defined needs of the students. Wherever required, additional instructional sessions and allied inputs are arranged for students/participants.



Some Broad Guidelines

Undergraduate Programs

Undergraduate engineering students are taught a series of courses in basic sciences to develop understanding of scientific principles and methods, analytical ability and rigor. These courses are followed by courses in engineering sciences to provide a smooth transition from basic sciences to professional engineering courses. A series of courses in technical arts are designed to develop engineering skills through training in engineering drawing, measurements, computing skills, manufacturing technology and effective communication. The professional courses in the chosen field of specialization are meant to develop creative abilities for the application of basic and engineering sciences to engineering problems involving planning, design, manufacturing, maintenance and research and development. In addition, courses in humanities and social sciences are incorporated to develop appreciation of the impact of science and technology on society. The undergraduate curriculum consists of two main components i.e. core courses and professional courses. The core courses lay emphasis on concepts and principles. It involves teaching of subjects in Basic Sciences, Humanities and Social Sciences and Engineering Science.Attention is also paid to develop communication skills in English language - the medium of instructions. The professional courses lay emphasis on system analysis, design, manufacturing and professional practice. There is an in-built flexibility to encourage students to specialize in streams of their choice through a system of professional and free electives. The institute strivesto foster among its students a strong desire and capacity for continuous learning as well as self- appraisal to develop sterling human & professional qualities and a strong sense of service to society through designed, curricular, co-curricular activities and congenial campus environment.

Post-graduate Programs

MASTER OF ENGINEERING/TECHNOLOGY (M.E./M.Tech.)

The institute in offering various M.E./M.Tech. programs has uniformly maintained the basic structure and philosophy of the post-graduate education in engineering in the country. All these programs, regular or part-time, have their course work classified into two major categories: Core Courses and Elective Courses. The core courses are aimed at imparting knowledge of therelevant basics analytical-tools & techniques necessary to build-up on them elective (professional) courses. Core courses of a particular programme are compulsory for all thestudents registered in that programme. Elective courses are of professional nature. To be eligible for a degree, a student must complete requisite number of core and elective courses. However, tobring in flexibility a wide choice of electives is offered to the students in order to make their training broad based. Presentation of a seminar and a project in addition to the course work and further carrying out a thesis/dissertation are necessary components of post-graduate degree. The seminar and project should be on a topic relevant to the area of study, presenting the state-of-art work done on the subject. The literature survey conducted during the preparation of the seminar should highlight the areas for further research work on the subject. The problem taken up for the thesis/dissertation should be as far as possible on the work done for the seminar. Both theseminar and thesis/dissertation are submitted in bound form and are presented during their

respective evaluation. In case a student fails to undertake, complete & clear thesis work and completes seminar only he will be eligible for award of post-graduate diploma only.

MASTER OF COMPUTER APPLICATIONS (M.C.A.)

The MCA program aims to train and produce much needed human resource for software industry as increasing applications of computers in almost all areas of human endeavour has led to a vibrant software industry with concurrent rapid technological changes. The programme is spread over a period of three years consisting of six semesters. The students study courses for five semesters in the institute and carryout a Software Development Project (SDP) in the sixth semester in reputed national/multinational companies. The graduates of this programme are absorbed as software professionals, solution developers and system analysts in leading national/multinational companies and other industrial/service organizations working in the area of Information Technology (IT).

MASTER OF SCIENCE (M.Sc.)

M.Sc. program aims to impart application-oriented education in the respective area with an integrated approach so as to turn out professionals who will have easy absorbability in industry as well as self-employment skills. The course curriculum has been structured to impart education in the areas desired by the industry as well as local needs. The programme is spread over four semesters, which include teaching of both core courses as well as elective courses for first two semesters, a project in the third semester and a dissertation in the final semester.

DOCTORAL PROGRAM

High caliber students with demonstrated capability can register themselves for Ph.D. degrees. There is a laid down course work requirement for the Doctoral Degree Program for candidates registering after obtaining M.E. degree. The provisions in the rules and regulations governing the programme, aim at ensuring high quality of research leading to Ph.D. degree. Ph.D. program are offered on both regular and part-time basis. Ph.D. thesis is evaluated by a panel of examiners drawn from the peer group on the topic, both from India and abroad.

COURSES SCHEME & SYLLABUS

M.E. TRANSPORTATION ENGINEERING

Program Educational Objectives and Program Outcomes

M.E. (Transportation Engineering) Program

The postgraduate degree program in Transportation Engineering at Thapar Institute of Engineering and Technology is designed to prepare postgraduates for professional practice in industry and government sector and for further education to enter careers in research and academia.

To prepare our students to take their place in this environment, and consistent with this focus, the following **Program Educational Objectives** have been established for the students of Masters in Transportation Engineering.

Program Educational Objectives:

PEO1	To impart knowledge to students in the latest technological aspects of transportation engineering projects and to provide them with opportunities in taking up advanced topics in the field of study.
PEO2	To enable students to have a strong analytical and practical knowledge of planning, designing and solving transportation problems.
PEO3	Moulding the graduate civil engineers to undertake safe, economical and sustainable design of transportation projects
PEO4	To broaden and deepen their capabilities in experimental research methods, analysis of data, and drawing relevant conclusions for scholarly writing and presentation.
PEO5	To inculcate in students professional and ethical attitude, effective communication skills, teamwork skills, managerial skills multidisciplinary approach, and an ability to relate engineering issues to broader social context.

Program outcomes of the Masters in Transportation Engineering program.

At the completion of the M.E. program in Transportation Engineering, the student will be able to

PO1	Design, analyze, and evaluate systems in Transportation Engineering Projects.
PO2	Critically assess the relevant advanced technological issues.
PO3	Conduct experimental and/or analytical work and analyzing results using modern mathematical and scientific methods.
PO4	Formulate relevant research problems and critically assess research of their own and of others.
PO5	Write clearly and effectively for the practical utilization of their work.

COURSE SCHEME FOR M.E. (TRANSPORTATION ENGINEERING)

SEMESTER – I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PTE101	PAVEMENT MATERIALS AND CONSTRUCTION PRACTICES	3	0	2	4.0
2	PTE102	GEOMETRIC DESIGN OF TRANSPORTATION FACILITIES	3	2	0	4.0
3	PCL105	STATISTICAL METHODS AND ALGORITHMS	3	0	2	4.0
4	PTE104	ADVANCED FOUNDATION ENGINEERING	3	2	0	4.0
5	PTE105	TRAFFIC ANALYSIS & DESIGN	3	2	0	4.0
6		ELECTIVE-I	3	0	0	3.0
TOTAL			**18**	**6**	**4**	**23.0**

SEMESTER – II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1.	PTE201	REMOTE SENSING AND GIS IN TRANSPORTATION DEVELOPMENT	3	0	2	4.0
2.	PTE202	TRANSPORTATION PLANNING, MODELING & SIMULATION	3	0	2	4.0
3.	PTE203	PAVEMENT ANALYSIS & DESIGN	3	1	2	4.5
4.	PTE204	ROAD SAFETY ENGINEERING	2	2	0	3.0
5.	PTE205	ADVANCED RAILWAY AND AIRPORT ENGINEERING	3	1	0	3.5
6.		ELECTIVE-II	3	0	0	3.0
TOTAL			**17**	**4**	**6**	**22.0**

Approved in the 113th Meeting of Senate held on September 7, 2024

SEMESTER – III

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1.	PTE391	SEMINAR	-	-	-	4.0
2.	PTE392	MINOR DESIGN PROJECT	-	-	-	4.0
3.	PTE491	DISSERTATION (STARTS)	-	-	-	-
TOTAL			**-**	**-**	**-**	**8.0**

SEMESTER – IV

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1.	PTE491	DISSERTATION	-	-	-	16.0
TOTAL						**16.0**

TOTAL NUMBER OF CREDITS: 69.0

ELECTIVE – I

S. NO.	COURSE NO.	TITLE	L	T	P	CR
1.	PTE107	TRANSPORT ECONOMICS & FINANCIAL ANALYSIS	3	0	0	3.0
2.	PTE108	INTELLIGENT TRANSPORTATION SYSTEMS	3	0	0	3.0
3.	PTE109	ENVIRONMENTAL LEGISLATION AND IMPACT ASSESSMENT	3	0	0	3.0
4.	PTE110	URBAN TRANSPORTATION INFRASTRUCTURE: PLANNING AND DESIGN	3	0	0	3.0
5.	PTE111	STRUCTURAL MATERIALS	2	0	2	3.0

ELECTIVE – II

S. NO.	COURSE NO.	TITLE	L	T	P	CR
1.	PTE207	ADVANCED BRIDGE DESIGN	3	0	0	3.0
2.	PTE208	SITE EXPLORATION & FIELD TESTING	1	0	4	3.0
3.	PTE209	ADVANCED HIGHWAY MATERIAL CHARACTERISATION	2	0	2	3.0
4.	PTE210	INTERSECTION DESIGN & CONTROL	3	0	0	3.0
5.	PTE211	PAVEMENT EVALUATION, REHABILITATION AND MAINTENANCE	3	0	0	3.0

Approved in the 113th Meeting of Senate held on September 7, 2024

PTE101: PAVEMENT MATERIALS AND CONSTRUCTION PRACTICES

L	T	P	Cr
3	0	2	4.0

Course Objectives: The course aims to equip students with a comprehensive understanding of soil, aggregates, bituminous binders, mix design methodologies, and highway construction practices essential for designing, constructing, and maintaining pavement infrastructure. Students will gain knowledge about material properties, testing methods, mix design techniques, and construction practices crucial for efficient pavement infrastructure development and adherence to relevant specifications.

Soil and Aggregate: classification and identification of soil, tests relevant to highways, sand equivalent test, soil stabilization techniques; Aggregates: origin, classification, production, properties, tests, sampling, gradation and blending

Bituminous binders: paving bitumen, bituminous emulsions, cutbacks, modified binders; tests on bitumen, refining, modified bitumen, emulsions; grading systems; aging; rheology; viscoelastic models

Mix design: Marshall method, Superpave method, design of cold mixes, performance tests for rutting, fatigue, resilient and dynamic modulus

Other topics: requirements and design of paving concrete, design of dry lean concrete, alternative pavement materials and admixtures

Highway Construction Practices: embankment, formation cutting, subgrade, ground improvement, granular and stabilized bases/subbases, bituminous surfacing, recycled pavements, concrete pavements, non-conventional pavements, equipment for road construction, MoRTH specifications.

Laboratory tests:

- Tests on soil and aggregates
- Tests on neat and modified bitumen, emulsions
- Formulation and design of granular base and subbase, bituminous mixes,
- Formulation and design of paving concrete mixes
- Design with alternative pavement materials

Course Learning Outcomes (CLO):

After the completion of this course the student will be able to:

1. Understand the properties and tests for soil, aggregates, and bituminous binders, including grading systems and rheological behaviour.
2. Conduct bituminous and paving concrete mix designs.
3. Implement highway construction practices, including embankment, subgrade, subbase/base layers, and bituminous or concrete surfacing.
4. Evaluate alternative pavement materials and admixtures for sustainability and cost-effectiveness in construction.

Recommended Books

1. *MoRTH. Specifications for Road and Bridge Works (5th Revision), Ministry of Road Transport and Highways, 2013.*
2. *E R Brown, P S Kandhal, F L Roberts, Y R Kim, D Y Lee. Hot Mix Asphalt Materials, Mixture Design and Construction. 3rd Edition, NAPA Education Foundation, 2023.*
3. *P S Kandhal. A Veeraragavan, R Choudhary. Bituminous Road Construction in India, PHI Learning, 2nd Edition, 2023.*
4. *Norbert Delatte. Concrete Pavement Design, Construction and Performance, 2nd Edition, CRC Press, 2014.*
5. *A Nikolaides. Highway Engineering: Pavements, Materials and Control of Quality. CRC Press, 2015.*
6. *Relevant IRC, ASTM, AASHTO standards and guidelines.*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	40
3	Sessionals (May include lab evaluation /assignments/ quizzes/ mini projects)	30

PTE102: GEOMETRIC DESIGN OF TRANSPORTATION FACILITIES

L	T	P	Cr
3	2	0	4.0

Course Objective: Development and application of concepts of geometric design for rural and urban highways. Design controls and criteria, elements of design including sight distance, horizontal and vertical alignments, cross section elements, intersection elements, grade separation and interchanges. Computer applications using the MX-Road/OpenRoads/ Civil3D software's.

Introduction: Traffic characteristics, topography and physical features; design controls; speed and safety; space standards for urban; rural and hill roads, access controls, location and spacing of access points.

Human and Vehicle Factors: Perceptions and application of human factors in the design and representative vehicle factors used in geometric design, driver expectancy and errors, considerations of high-speed highway facilities.

Cross-section Elements: Single lane, two lane, multi-lane highways, expressways and urban roads; street design concepts; bicycle tracks; pedestrian facilities; street furniture; design of speed breaker, road side clear zones.

Highway Alignment: Horizontal alignment; curve design; super-elevation design; friction coefficient; transition curve design; attainment of super-elevation; pavement widening; sight distance on horizontal curves; vertical alignment; gradients; grade compensation; design of vertical curves, 3D alignment and analysis; alignment coordination, vertical clearance for underpass and elevated structures, hill roads considerations, Computer applications using the MX-Road/Open Roads/Civil 3D software's.

Intersection and Interchange Design: Design consideration and objectives, visibility requirements, principles of channelization, types of intersections and design, roundabouts, interchange design; on-ramps (flyovers and access-controlled facilities), acceleration and deceleration lanes, two-way turn lanes. Computer applications using the Auto-tracker, Civil3D software's.

Geometric design consistency: Evaluate inconsistency of geometric design; likelihood of the crashes; reliability-based design; engineering safety measures, traffic calming measures.

Design of Facilities: Design of parking facilities (on-street, off-street, and multi-storied); design of bus shelters and bus lay-bye, bus terminal, truck terminals and truck lay-bye, container terminal, toll plaza, foot-over bridge and sky-walk, road side amenities.

Course Learning Outcomes (CLO):

After the completion of this course the student will be able to:

1. Design horizontal and vertical alignments, sight distances, and super elevation for different types of roads and traffic conditions.
2. Design intersection and interchange design and other traffic control devices.

3. Design the Pedestrian, Parking & other facilities related to transportation projects.

Recommended Books

1. *S. K. Khanna, C. E. G. Justo, A. Veeraragavan Highway Engineering, Nem Chand & Brothers, 10th Edition, 2019.*
2. *P. H. Wright and Karen K. Dixion, Highway Engineering, Wiley India, 7th Edition (2014)*
3. *IRC: 73-2023 Geometric Design Standards for Rural (Non-Urban) Highways*
4. *IRC: 86-2018 Geometric Design Standards for Urban Roads & Streets.*
5. *IRC: SP: 48-2023: Hill Road Manual.*
6. *Indo-HCM: Indian Highway Capacity Manual (Indo-HCM). CSIR-Central Road Research Institute (CRRI), New Delhi (2017).*
7. *Transportation Research Board (TRB), Highways Capacity Manual, National Research Council, Washington D.C. (2022 edition).*
8. *Relevant IRC, ASTM, AASHTO standards and guidelines.*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	40
3	Sessionals (May include Tutorial Evaluation / assignments/ quizzes/ mini projects)	30

PCL105: Statistical Methods and Algorithms

L	T	P	Cr
3	0	2	4.0

Course Objective: To learn, understand and implement different techniques related to probability distributions and statistical models.

Introduction: Nature and objectives of research, Study and formulation of research problem. Scope and formulation of hypothesis. Preparation and presentation of research proposal using statistical package.

Review of Probability: Appraisal of axiomatic approach of probability, Conditional probability, Bayes' rule, Conditional distributions, and conditional expectations.

Markov chains: Basics of Markov chains, Finite state space, Markov chains, Transition and stationary Markov chains. Continuous time Markov process: continuous time branching processes, Kolmogorov, Forward and backward equations, Pure birth, Pure death, Birth and death process.

Analysis of variance: One Way Classification: ANOVA for fixed effect model, ANOVA for Random Effect Model, Two-way Classification (one observation per cell): ANOVA for fixed effect model, ANOVA for Random Effect Model.

Design of Experiments: Completely Randomized Design, Randomized Block Design, Latin Square Design, their statistical analysis and variance of estimates, Analysis of Covariance.

Multivariate Data Analysis: Introduction, multivariate normal distributions, Mean vector, Variance-covariance matrix, Correlation matrix and their estimation for multivariate data. Stepwise regression, Selection of best set of variables, Classification and discrimination problems. Factor analysis and principal component analysis. Illustrative examples and Multivariate data analysis using statistical package.

Time Series and forecasting: Components of time series, Analysis of time series, Measurement of trend, Measurement of seasonal variations, Measurement of cyclic variations, Auto-Regression Analysis, Auto-correlation, Random component in time series. Computer applications using the Excel for Statistical Analysis.

Laboratory Work: Implementation of statistical techniques using statistical packages viz. SPSS, Mathematica including evaluation of statistical parameters and data interpretation, Regression Analysis, covariance, Analysis of variance, multivariate data analysis and problems based on time series and forecasting

Recommended Books

1. *Medhi, J., Stochastic Processes, New Age International (2005).*
2. *Populis,A., Random Variables and Stochastic Processes, Tata McGraw Hill (2002).*
3. *Montgomery, Introduction to Statistical Quality Control, John Wiley and Sons (2005).*
4. *Bhuyan,K.C., Multivariate Analysis and Its Applications, New Central Book Agency (2002).*
5. *Anderson,T.W., An Introduction to Multivariate Statistical Analysis, John Wiley and Sons (2003).*
6. *Goon, Das, Gupta, Fundamental of Statistics Vol.-II, World Press (1999)*

Course Learning Outcomes (CLOs)

1. Compute the probabilities of composite events along with an understanding of the random variables.
2. Perform and interpret the various design of experiments and their implementation using different statistical software.
3. Measure the different components of the time-series.
4. Learn the Markov processes with a study of stochastic process, multivariate data and their applications to real word problems.

Evaluation Scheme:

S No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/LabEvaluations)	30

PTE 104: ADVANCED FOUNDATION ENGINEERING

L	T	P	Cr
3	2	0	4.0

Course Objectives: To understand the concepts of bearing capacity of soil so as to have deeper understanding in the design of foundations

Shallow foundations: Terzaghi's bearing capacity equation, General bearing capacity equation, Meyerhof's, Vesic theory, Effect of water table, Special footing problems, I.S. Codes, Footing pressure for settlement on sand, Soil pressure at a depth, , Computation of settlements, Inclined and Eccentric Loads, Uplift Capacity of Footings

Pile foundations: Classification of piles, estimating pile capacity by dynamic formula, static methods, Pile load tests, Pile group Capacity, Efficiency, Settlement of Pile group, Negative skin friction, Modulus of sub-grade reaction for laterally loaded piles, Lateral resistance by IS codes, I.S. Codes. Uplift Capacity of Piles

Well Foundations: Types (open end, closed or box, Pneumatic, Drilled), Shapes, Bearing capacity, Construction, Tilts & shifts, Stability of well foundations by IRC Method,

Sheet pile Structures: Types, Cantilever, Anchored sheet, Design by free earth & fixed earth method, Open cuts, braced sheeting, Cofferdams, Types of coffer dam, stability Checks.

Analysis and design of High Embankment: Design of High Embankment as per IRC: 75-2015 guidelines. Computer applications / software's for design of high embankments. Construction of High Embankment with Free Slope/ RE Wall/ & Retaining Walls

Reinforced Earth: Types of Geosynthetics, Function, and Application. Introduction to RE/RS wall, Mechanics of Reinforced soil, Components of RE/RS wall, Design of RE/RS wall, external stability, internal stability, Construction of RE/RS wall

Assignment / Project: Design of Pile and Well foundations based upon real project site specific data. Assignment on design of high embankments using software's.

Course Learning Outcomes (CLO):

After the completion of this course the students would be able to:

1. Understand the concept of evaluation of bearing capacity for shallow foundations
2. Evaluate the load carrying capacity of pile and well foundations
3. Analyze and design the high embankments.
4. Design the Reinforced earth wall sections.

Recommended Books:

1. *Bowles, Joseph E, Foundation Analysis and Design, Tata McGraw Hill(2001).*
2. *Coduto, Donald P, Foundation Design: Principles and Practice, PrenticeHall (2001).*
3. *Murthy, V.N.S., Advanced Foundation Engineering, C.B.S. Publishers (2007).*
4. *Saran Swami, Reinforced Soil and its engineering applications, IK International Publishing house. (2017)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25

PTE 105: TRAFFIC ANALYSIS AND DESIGN

L	T	P	Cr
3	2	0	4.0

Course Objectives: The course aims to provide students with a comprehensive understanding of traffic engineering principles and practices. Students will learn to analyze traffic streams, conduct various traffic studies, apply statistical techniques, model traffic behavior, design intersections and roadways, and implement effective traffic management strategies to ensure safe and efficient movement of road users.

Introduction: Elements of traffic engineering, road user, vehicles, highway and control devices. Classified Traffic Volume Surveys, PCU factors, ADT and AADT, Seasonal factors

Traffic Studies: Traffic stream parameters, time space diagram, fundamental relationships, macroscopic fundamental diagrams; traffic volume studies, speed, travel time and delay studies, parking studies, RSI survey, accident data collection, pedestrian studies

Microscopic Modeling: time headway, random, constant and intermediate headway state, car following theory

Traffic Design: Capacity and level of service analysis concepts – urban streets and rural highways, design of parking facilities, street design

Traffic Management: traffic signs, traffic calming measures, congestion and road user pricing, priority movements, traffic regulations and control systems.

Intelligent Transportation Systems for Traffic: Introduction to ITS, data collection techniques, sensors, AVL, AVI, GIS, traffic management centers, advanced traffic management systems, ITS case studies in India and other countries.

Statistical Applications in Traffic Engineering: Probability functions and statistics, normal distribution and applications, confidence bounds, sample size, binomial and Poisson distributions, hypothesis testing, ANOVA

Tutorials / Experiments:

- Itemization of traffic control devices
- Traffic volume (CTVS, ADT) studies
- Spot speed studies
- Parking studies
- Traffic stream parameters study
- Intersection geometrics study
- Delay studies
- Introduction to traffic engineering software

Course Learning Outcomes (CLO):

After the completion of this course the student will be able to:

1. Interpret traffic parameters and analyze fundamental relationships in traffic flow.
2. Conduct traffic studies, including volume, speed, parking, pedestrian, and accident data collection.
3. Apply statistical techniques like probability functions and hypothesis testing to analyze traffic data effectively.
4. Design roadways, intersections, and traffic control devices considering capacity, level of service, and safety requirements.

Recommended Books

1. *R P Roess, E R Prassas, and W R McShane. Traffic Engineering, 5th Edition, Pearson, 2019.*
2. *A D May. Traffic Flow Fundamentals, Prentice Hall Inc, 1990.*
3. *C F Daganzo. Fundamentals of Transportation and Traffic Operations, Emerald, 1997.*
4. *S P Washington, M G Karlaftis and F L Mannering. Statistical and Econometric Methods for Transportation Data Analysis, CRC Press, 2020.*
5. *P Chakroborty and A Das. Principles of Transportation Engineering. PHI Learning, 2017.*
6. *Indo- Highway Capacity Manual, CRRI, 2017.*
7. *Relevant IRC standards and guidelines.*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	30
2	EST	40
3	Sessionals (May include tutorial evaluations/assignments/ quizzes/ mini projects)	30

PTE201: REMOTE SENSING AND GIS APPLICATIONS

L	T	P	Cr.
3	0	2	4.0

Course Objectives: To analyze the remote-sensed data for solving geospatial problems.

Course Contents:

Principles and Fundamentals of Remote Sensing: Sources of Energy – Active and Passive radiation – Electromagnetic Radiation – Nomenclature, Reflectance, Transmission and Absorption,

Thermal Emission – Plank's formula, Stefan – Boltzman Law, Wein's Displacement Law; Emissivity – Kirchoff's Law, Characteristics of Solar Radiant Energy.

Sensors and Platforms: Types of sensors, Multispectral, hyper spectral, thermal, orbital characteristics, working principles and instrumentation. Storage and Retrieval of data - IRS and ERS satellite systems – Introduction, Stages of development, Sensory Characteristics, Orbit and Coverage's, various types of data product and its uses.

Data Processing: Initial data statistics. Pre-processing – Atmospheric, Radiometric and Geometric corrections.

Data analysis: Image Interpretation Elements, Keys and Aids. Basic Instrumentation - Visual analysis of data in application of remote sensing to various engineering fields

Principles of Geographical Information Systems (GIS): Geographic information and spatial data types, Hardware and software; GIS; Steps of spatial data handling, database management systems, Spatial referencing

Data: Quality, measures of location errors on maps, Satellite-based positioning, Spatial data input, data preparation, Point data transformation

Analytical GIS capabilities; retrieval and classification; overlay functions, neighbourhood operations; network analysis; error propagation, Data visualization.

GIS Applications in Transportation Infrastructure Projects.

Laboratory work:

Introduction to various types of remote sensing data; Introduction to image enhancement and classification techniques; Introduction to GIS software and understanding of GIS data and data formats; Delineation of watershed and drainage pattern using digital elevation models; Application of GIS in transportation analysis and planning; Utilizing GIS to facilitate route planning; Us of GIS for development of Pavement Maintenance Management Systems for various categories of Highways.

On the completion of course, students will be able to:

- Design the various processes involved in remote sensing
- Processes the raw data and prepare the final product after necessary corrections
- Interpret the remotely sensed data
- Learn the use geospatial data for the benefit of the end users

Recommended Books

1. *Lillisand, T.M. & Kiefer R.W, Remote Sensing and Image Interpretation, John Wiley and Sons, (2004).*
2. *Campbell, J.B., Introduction to Remote Sensing, Taylor and Francis, (2002).*
3. *Nag. P. & Kudrat, M., Digital Remote Sensing, Concept Publication Company, (1998).*
4. *Jhanwar, M.L. and Chouhan, T.S., Remote Sensing and Photogrammetry – Principles and Applications, Vigyan Prakashan, Jodhpur, (1998).*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	30
2	EST	40
3	Sessionals(May include assignments/quizzes/tutorial)	30

PTE202: TRANSPORTATION PLANNING, MODELING & SIMULATION

L	T	P	Cr
3	0	2	4.0

Transportation Planning Process - Planning in System Engineering Framework - Concept of Travel Demand - Methods of Travel Demand Estimation - Definition of Study Area - Zoning - Trip Generation Analysis - Trip Distribution Analysis - Mode Split Analysis and Route Split Analysis - Land use-Transportation Models - Location models - Opportunity Models, Lowry based Land use-Transportation Models – Urban form & Urban structure.

Demographic and Employment Forecasting Models - Theories of Regional Development & Delineation of Transportation Planning Regions - Estimating and Forecasting of Passenger and Goods Demand - Models based on Behavioural Characteristic of Shippers, Demand Forecasting using Link Volume Modelling Philosophy - Urban Bus Transportation Planning and Evaluation - Accessibility Considerations - Marginal Ridership - Scheduling of Buses

Transportation simulation & modelling- Decision making, issues in transport modelling, structure of transport models

Multivariate Data Analysis Techniques: Types of Data, Basic Vectors and Matrices, Sample Estimate of Centroid, Standard Deviation, Dispersion, Variance and Covariance, Correlation Matrices, Principal Component, Factor Analysis, Manova and Cross Classification Procedure in Multivariate Data Analysis and Application to Problems in Traffic and Transportation Planning, best fit analysis, Distribution analysis.

Discrete Choice Models: Theoretical framework, specification and functional form of models, statistical estimation and validation of models, binary choice, multinomial and nested logit models, modelling with stated preference data, model aggregation, updating and transferability. Simplified Transport Models, Sketch planning method, Model estimation from traffic count.

Time Series Analysis: Basic Components of Time Series – Stationary and Non-Stationary Process – Smoothing and Decomposition Methods – Correlation and Line Spectral Diagrams – Auto Correlations and Moving Averages.

Traffic Simulation: Monte Carlo method; Generation of Pseudorandom Numbers; Discrete Random deviates; Simulation methods; Fundamentals of simulation, Introduction to factorial experimental designs, Fractional factorial design, Components of traffic simulations models, vehicle arrival and movement models, mixed traffic flow simulation, Simulation model development strategies; Study of large scale simulation models; Scanning Technique; Time based and Even-based methods; Examples of Macroscopic, Mesoscopic, and Microscopic based simulation models, Calibration and Validation of Simulation Models; methodology for calibrating and validating a microscopic traffic simulation model; Case studies of application of simulation for various transportation engineering problems.

VISSIM Microsimulation Software

Recommended Books:

1. Joseph F. Hair, Jr., William C. Black, Barry J. Babin and Rolph E. Anderson, 'Multivariate Data Analysis', Prentice Hall, 2010
2. Ortuzar de D.O. & Willumsen, L.G., "Modelling Transport", John Wiley & Sons, 1993.
3. Hutchinson, B.G. "Principles SCRIPTA Book Company. of Urban Transport Systems Planning", 1974.
4. Taniguchi, E., Thompson, R. G., Yamada, T., and Duin, R. V., City Logistics – Network Modelling and Intelligent Transport Systems, Pergamon, 2001.
5. Barceló, J. "Models, Traffic Models, Simulation, and Traffic Simulation". Barceló, J. ed. Fundamentals of traffic simulation. New York: Springer, 2010.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	40
3	Sessionals(May include assignments/quizzes/tutorial)	30

PTE203: PAVEMENT ANALYSIS AND DESIGN

L	T	P	Cr
3	1	2	4.5

Course Objectives: To understand the various design & maintenance aspects of the pavements using IRC guidelines & Software's.

Introduction: Factors Affecting Pavement Design, Variables Considered in Pavement Design, Types of Pavements, and Functions of Individual Layers, Classification of Axle Types, Tire Pressure, Contact Pressure, EAL and ESWL Concept, Lane Distributions & Vehicle Damage Factors.

Stresses And Deflections in Flexible Pavements: Stresses and deflections in homogeneous masses. Burmister's two-layer theory, three layer and multilayer theories.

Flexible Pavement Design: Design Methods Principle, design steps, advantages and applications of different pavement design methods – Group Index, CBR, McLeod, Kansas Triaxial test, IRC, AASHTO and Asphalt Institute methods. Design of flexible pavements using Geosynthetics.

Stresses in Rigid Pavements: Factors affecting design and performance of pavements. Types of stresses and causes, factors influencing the stresses, general considerations in rigid pavement analysis, EWL, wheel load stresses, warping stresses, frictional stresses, combined stresses.

Rigid Pavement Design: Types of joints in cement concrete pavements and their functions, joint spacing, design of CC pavement for roads and runways, design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method. Design of continuously reinforced concrete pavements. Design of low volume CC roads. Design of rigid pavements using Geosynthetics.

Overlay design for Pavements using IRC: 81, IRC: 115 & IRC: 117, Design of white toppings.

Laboratory Work*:* Test pit investigations & Deflection studies using BBD & FWD, Network survey vehicles (NSV) studies.

Software's application for the course:

i. IITPAVE
ii. KENPAVE
iii. KGPBACK
iv. ELMOD

v. Excel sheets for IRC:37, IRC58, IRC115, IRC117, IRC:62 & IRC:72

Assignments / Projects:-

1. Design the flexible pavement as per IRC 37:2018 for the given traffic data.
2. Design the rigid pavements as per the IRC: 58 guidelines.
3. Design of overlay for the sections using FWG & BBD.

Course Learning Outcomes (CLO):

After the completion of this course the student will be able to:

1. Perform the design of the flexible pavements using IRC design methods.
2. Perform the design of the rigid pavements using IRC design methods.
3. Perform the overlay design for flexible and rigid pavements.

Recommended Books:

1. *Yoder, E.J & Witczak., Principles of Pavement Design, 2nd Edition, John Wiley & Sons, Inc. New York, (1991).*
2. *Khanna, Justo & Veeraragavan, Highway Engineering – Nem Chand & Brothers, Roorkee, (2017).*
3. *Kadiyali L. R. Principles & Practice of Highway Engg. Khanna Pub. (2000).*
4. *Chakroborty , P., Das A, Principles of Transportation Engg., PH1, (2005).*
5. *IRC:37-2018 "Guidelines for the design of flexible pavements"*
6. *IRC:58-2015 "*Guidelines for the Design of Plain Jointed Rigid Pavements for Highways"
7. *IRC:115-2014 "Guidelines for Structural Evaluation and Strengthening of Flexible Road Pavements Using Falling Weight Deflectometer (FWD) Technique"*
8. *M. Rashad Islam & Rafiqul A. Tarefder, Pavement Design: Materials, Analysis, and Highways, 1st Edition, 2020*
9. *IRC:117-2015 "Guidelines for the Structural Evaluation of Rigid Pavement by Falling Weight Deflectometer"*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25

PTE204: ROAD SAFETY ENGINEERING

L	T	P	Cr
2	2	0	3.0

Course Objective:

The primary objectives of the course are to highlight the need for road safety and identification of various factors contributing to road crashes & exposing students about road crash data collection procedure, its analysis, prioritization, management and derivation of preventive countermeasures, and, before-after evaluations including road safety audits at various stages of project.

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

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

Road Safety Audits (RSA): Key elements of a road safety audit, Introduction to RSA, Feasibility stage audit, Design stage road safety audit, Construction stage audit, Pre- and post-opening stage audit, Audit reports preparation.

Crash Investigation: Describe the basic information that can be obtained from the roadway surface, understand 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.

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; Safety in urban areas; Public transport and safety; Road safety policy making, Stakeholders involvement; Road safety law.

Course Learning Outcomes (CLO):

After the completion of this course the student will be able to:

1. Conduct various stage road safety audits for the highway projects.
2. Perform Statistical Interpretation and Analysis of Crash Data.
3. Design suitable mitigation measures to rectify black spots on highways.

Recommended Books:

1. Athelstan Popkess, Traffic Control and Road Accident Prevention, Chapman and Hall, 1997 (Digitized 2008)

2. Ezra Hauer, Observational Before-After Studies in Road Safety, Pergamon Press, 1997 (reprinted 2002).

3. Geetam Tiwari and Dinesh Mohan, Transport Planning and Traffic Safety: Making Cities, Roads, and Vehicles Safer, CRC Press, 2016.

4. Institute of Transportation Engineers (ITE), The Traffic Safety Toolbox: A Primer on Traffic Safety, ITE, 1999.

5. J. Stannard Baker, Traffic Collision Investigation, Northwestern University Centre for Public Safety, 2002

6. IRC: SP:88-2019 "Manual on Road Safety Audit"

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	40
3	Sessionals (May include assignments/quizzes)	30

PTE 205: ADVANCED RAILWAY AND AIRPORT ENGINEERING

L	T	P	Cr
3	1	0	3.5

Course Objectives: To understand the various advanced aspects of railway and airport engineering.

Railway Engineering: Importance of transportation systems. History of railways and its development, development of Indian Railways - Surveys for Route location - Permanent way and its component parts Formation, Ballast, Sleepers, Rails. Creep and Tilt in Rails. Track fittings and fastenings, Geometric Design of Railway tracks- Points and crossings - Track resistance and tractive effort. Gauge problem, super- elevation near branching of curves; gradients - Station Platforms - Various types of yards and sidings – Signals, Modernization of Indian Railways, various types of railway track maintenance, surface defects and their remedial measures

Airport Engineering: Introduction, classification of airports; planning, Surveys and site selection of airports. Airport Geometrics**:** Runway Length, Patterns and orientation- wind rose diagram - Width and grades of runway; Taxiways and aprons, Airport Markings & Lightings. Airport Pavement Design**:** Difference between Highway and airport pavements; Introduction to various FAA design methods for various types of airport pavements, FAARFIELD Software, LCN-ACN methods of the Pavement Evaluation, COMFAA Software, Pavement Management Systems for the airport pavements, Airport drainage. exit taxiway geometry, location of exit taxiways, design of taxiway curves and intersections, and end-around taxiways

Assignment / Project:

1. To design the flexible & rigid runway & apron pavements.
2. To design the turnout as per the Indian Railway specifications.

Course Learning Outcomes (CLO):

After the completion of this course the student will be able to:

1. Design the permanent way sections for the railways.
2. Perform the geometric design of runways and taxiways.
3. Design & evaluate the various airport pavements.
4. Develop the Pavement Management System for airport pavements.

Recommended Books:

1. *Rangawala, S.C., Railway Engineering, Charotar Publishers, Anand, (2002).*
2. *Arora, S.P. and Saxena., Railway Engineering, Dhanpat Rai Publishers, NewDelhi, (2001).*
3. *Khanna, Arora and Jain. Airport Planning and Design, Nem Chand and Brothers,Roorkee, (2002).*
4. *Railway Engineering, Satish Chandra and M.M. Agrawal, Oxford University Press, New Delhi (2013).*
5. *Robert Horenjeff; Planning and Design of Airports (5th edition), McGraw HillBook Co. (2010)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	40
3	Sessionals (May include assignments/quizzes)	30

PTE391: SEMINAR

L	T	P	Cr
-	-	-	**4.0**

Course Objectives: To expose students to extensive literature review on the area of their research interest or the emerging technologies in the civil engineering industry

The seminar is carried out on one topic by each student so as to have state-of-the art knowledge on that area and to define the gray area in that topic so as to carry out further research in that area. Those students who have opted for one-year industrial project in industry can do the extensive review of emerging technologies in the industry. They shall be evaluated on the basis of project report and viva-voce examination.

Course Learning Outcomes (CLO):

After the completion of this course the student will be able to:

1. Identify domain specific scholarly research area or the detailed review of recent emerging technologies in industry.
2. Investigate and tabulate details and history about the selected topic
3. Enhance the technical report writing& presentation skills.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	Supervisor Evaluation	30
2	Report	20
3	Panel Evaluation	50

PTE392: MINOR DESIGN PROJECT

L	T	P	Cr
-	-	-	4.0

Course Objectives: This course is designed to encourage design projects where students take what they have learned throughout the course of their ME program and apply it to examine a specific idea.

Course Learning Outcomes (CLO):

After the completion of this course the student will be able to:

1. Investigate and identify real world problems
2. Design, develop and implement a domain specific design problem
3. Develop acumen for higher education and research.
4. Enhance technical report writing skills.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	Supervisor Evaluation	30
2	Report	20
3	Panel Evaluation	50

PTE491: DISSERTATION

L	T	P	Cr
-	-	-	16.0

Course Objectives: To expose students to research work in the area of their interest. Extensive research / research projects with some specific problems are carried out on one topic by each student by conducted experiments in the lab or by developing analytical models by using various software's. They shall be evaluated on the basis of dissertation and viva-voce examination.

Course Learning Outcomes (CLO):

The students will be able to:

1. Design and implementation of identified research problem.
2. Develop acumen for higher education and research.
3. Technical report writing and Publication of research work in referred journals, National and International conferences of Repute.
4. Ability to foresee how their current and future work will influence/impact the economy, society and the environment.

Evaluation Scheme:

Sr. No.	Evaluation Scheme	Weightage (%)
1	Evaluation by panel of examiners based upon subject matter, presentation, usefulness of work & viva voce	40
2	Supervisor & External Examiner Evaluation based upon subject matter, literature review, presentation, discussion of results & conclusions	50
3	Overall perception / Paper writing (Evaluated by Chairman, Evaluation Committee)	10

PTE 109: ENVIRONMENTAL LEGISLATION AND IMPACT ASSESSMENT

L	T	P	Cr
3	0	0	3.0

Course Objectives: To provide an overview on environmental legislation and acts applicable for environmental pollution; to facilitate understanding on role of pollution control boards and their procedure; and to facilitate understanding of various aspects related to EIA processes.

Definition of Terms: Conventions and protocols; Policy; law; acts and rules; Administrative and legal interpretations; Codes and specifications.

Overview of Environmental Legislation: Overview of Indian environmental law; Pollution control boards – Powers; functions and Procedures.

Provisions of Water Act; Water-cess Act; Air Act; Environmental Protection Act; Public Liability Insurance Act as Applicable to Industry: Provisions relating to Environmental clearance; Environmental sampling, analysis and reporting of results; Environmental standards; Overview of other key environmental regulations- Municipal solid waste rules; Biomedical waste rules; Hazardous waste, microorganisms, and chemicals rules;

Legal Aspects of EIA: EIA notification; Environmental clearance process - Screening; scoping; public consultation and appraisal; Objectives and scope of EIA; EIA processflow chart.

Project and the Environment Description: Environmental feasibility analysis; Baseline studies; and environmental data collection: Methods of Impact analysis- checklists; matrices; networks; overlays etc.

EMP (Environmental Management Plan) and EIA Documentation: Principles and Elements of approach; identification and mitigation of environmental impacts: types and structure of EIA documents.

Course Learning Outcomes (CLO):

After the completion of this course the student will be able to:

1. Becoming aware of the environmental legislation, environmental policies of the country and of the international environmental conventions and protocols.
2. Knowing the environmental regulations applicable to the industry and other organizations with significant environmental aspects.
3. Knowing about the environmental requirements applicable to the environmental impact assessment, and about the environmental clearance process of developmental projects.
4. Understanding the methods and tools of identification, prediction and evaluationof environmental impacts of developmental projects.

Recommended Books:

1. CPCB, Pollution Control Law Series - PCL/2/2001; Central Pollution Control Board (http://envfor.nic.in/cpcb/cpcb.html).

2. Jain R and Clark A, Environmental Technology Assessment and Policy; Ellis Harwood (1989).

3. EIA notification, Gazette Notification: SO 1533 dated 14-09-2006; MOEF. GOI (2006 to 2021).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	40
3	Sessionals(May include assignments/quizzes/Lab evaluations/Tutorials)	30

PTE 207: ADVANCED BRIDGE DESIGN

L	T	P	Cr
3	0	0	3.0

Course Objectives: To analyze and design various types of bridges.

General: Bridge System, Considerations in alignment, Planning, Economic consideration, Aesthetics and selection of type of bridge, loading standards.

Super Structure Analysis: Bridge deck analysis using different methods, Load distribution theories – specifications for loading, Geometrical proportioning etc. of road, rail-cum-road bridges, Indian Road Congress (IRC) and Indian Railway Loading standards and their comparison with loading, Hendry-Jaegar, Morris-Little (Orthotropic plate theories) methods, Stiffness method, Finite difference method, Folded Plate method, Finite strip method and Finite Element method (General treatment), Limit analysis, Design of bridge decks.

Continuous Bridges: Introduction to IRC 112: Provisions of Earthquake Resistant Design of Bridges

Connections: Design of different connections, Bearings and joints

Substructure Analysis and Design: Piers, Abutments, Wing walls and other appurtenant structures

Foundations: Well foundations and pile foundation, Design and construction and field problems

Construction & Maintenance: Erection of bridge super structure, Maintenance, Rating and Strengthening of existing bridges

Dynamics Behaviour: Behaviour of bridges under dynamic loads, Discussion of code provisions for design of bridges for wind and earthquake forces

Long Span Bridges: General discussion of suspension and cable stayed bridges

Assignment/Project: To design sub and super structure of RCC bridge

Course Learning Outcomes (CLO):

After the completion of this course the student would be able to:

1. Understand the concept of planning and investigation for bridges
2. Analyze and design superstructures for various types of RCC bridges
3. Analyze and design various types of substructures and foundations
4. Perform dynamic analysis of bridges

Recommended Books:

1. *Bakht, B. and Jaeger, L.G., Bridge Analysis Simplified, McGraw-Hill Book Company (1985).*
2. Bridge Engineering by S. Ponnuswamy (2007)
3. *Hambly, E.C., Bridge Deck Behaviour, Chapman and Hall. (1991).*
4. *Krishna Raju, N., Design of Bridges, Oxford and IBH Publications (1998).*
5. *Ponnuswamy, R., Bridge Engineering, Tata McGraw Hill (1997) .*
6. *Raina, V K, Concrete Bridge Practice, Tata McGraw Hill Publications (1991)*
7. *Essentials of Bridge Engineering, Victor D.J (6th edition 2019)*
8. *Relevant Road & Railway Codes for Bridges.*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	40
3	Sessionals (May include assignments/quizzes)	30

PTE 209: ADVANCED HIGHWAY MATERIAL CHARACTERISATION

L	T	P	Cr
2	0	2	3.0

Course Objectives: To introduce the advance technologies in pavement engineering materials and to make the students conversant with the characterization of various conventional and alternative road construction materials

Aggregates: Origin and Classification, physical mechanical and durability properties, sampling techniques, texture and skid resistance, polish stone value, Alkali-aggregate reactivity

Binders:

Bitumen: Bitumen sources and manufacturing, bitumen constituents and its properties, Structure and Rheology of bitumen, tests on bitumen-emulsion and cutback, modified bitumen and its types, goals of modification, properties of modified bitumen, long and short-term ageing of bitumen, other testes for modified bitumen, Microstructural Analysis of Asphalt, Sample preparation and handling,

Cement: origin, composition, types of cement, physical properties of cement.

Bituminous Mix Design:

Design of un-bound courses of flexible pavements, design of bituminous mixtures, desirable properties of mixes, theory of fillers and specifications, various design methods of bituminous mixes (MS2, Superpave, Balanced Mix design), Foam Asphalt Mix Design, Cold Mix Design

Concrete Mix Design, Factors influencing mix design, Microstructural Analysis of Concrete (Sample preparation and handling), Optical microscopy and image analysis, Scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS), X-ray diffraction (XRD) analysis, Other microstructural analysis techniques for concrete

Sustainable Pavement Materials: Recycle Concrete Aggregates, Reclaimed Asphalt pavement materials, use of industrial and agricultural waste for pavement construction, chemical and mineral admixtures.

Assignments / Projects :-

1. Rheology of Bitumen
2. Microstructural Analysis of Concrete.

Course Learning Outcomes (CLO):

After the completion of this course the student will be able to:

1. Understand the difference in the conventional and modified binder
2. Designing flexible pavements with international mix design methods
3. Able to understand the concept of Microstructural analysis of concrete

Recommended Books

1. *Yang H. Huang, Pavement Analysis and Design, Second Edition, Pearson Prentice Hall (2004)*
2. *Read, J. and Whiteoak, D., The shell Bitumen Handbook" Fifth Edition, Shell Bitumen, Thomas Telford Publishing, London*
3. *P.Kumar Mehta, Paulo J.M. Monteiro. Concrete microstructure, properties, and materials, Third Edition, Tata, McGraw-Hill Publishing Company limited, New Delhi (2006)*
4. *NAPA, Balanced mix design approach, https://www.asphaltpavement.org/expertise/engineering/resources/bmd-resource-guide*
5. *Federal Highway Administration, Superpave mix design, https://www.fhwa.dot.gov/pavement/materials/pubs/hif11031/hif11031.pdf*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	40
3	Sessionals (May include assignments/quizzes)	30

PTE107: TRANSPORT ECONOMICS & FINANCIAL ANALYSIS

L	T	P	Cr
3	0	0	3.0

Course Objectives: To introduce various concepts of transport investment & economics.

Course Description:

Concepts and Principles of Engineering Economics, Identification and Measurements of Highway Benefits, Highway Transportation Costs, Road User Costs and Benefits- Introduction to PPP - Concepts of BOO, BOT, BOOT, Road User Cost Study in India.

Overview of transportation economics: Transportation investments and economic development. Marginal analysis, opportunity cost, shadow price, money value of time, discounted cash flow, NPV, ROR, benefit-cost analysis. Road user costs; Public transportation economics; Social cost of transportation; Cost of congestion, pollution, traffic accidents. Taxation, regulations, financing transport systems; Legal framework for transportation sector.

Factors affecting Demand and Supply- Shift in Demand and Supply- Transportation demand Model- Equilibrium-Sensitivity of Travel DemandElasticities–determination of Elasticity from regression analysis -Consumer Surplus- Marginal Cost- Average Cost- Pricing- Concept of Road Prising-Problems.

Course Learning Outcomes (CLO):
At the end of this course, students should be able to:

1. Compare the benefits of transportation with its direct and social costs (externalities)
2. Understand various pricing policies for transportation services
3. Evaluate transportation infrastructure investment decisions
4. Understand the interplay between transportation economics, policy and regulation

Recommended Books:

1. Small, K. A. and Verhoef, E. T., The Economics of Urban Transportation (2nd ed.), Routledge, 2007.
2. Button, K., Transport Economics (4 th ed.), Edgar Elgar, 2022.
3. Nash, C. and Matthews, B. (eds.) Measuring the Marginal Social Cost of Transport, Research in Transportation Economics Vol. 14, Elsevier, 2005.
4. Brueckner, J. K., Lectures on Urban Economics, MIT Press, 2011.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	40
3	Sessionals (May include assignments/quizzes)	30

PTE108: INTELLIGENT TRANSPORTATION SYSTEMS

L	T	P	Cr
3	0	0	3.0

Course Objectives: To introduce various concepts of Intelligent Transportation Systems & its application.

Course description:

Introduction to Intelligent Transportation Systems (ITS); ITS Organizational Issues, the fundamental concepts of Intelligent Transportation Systems (ITS) in engineering, transportation systems, communication systems, vehicle technologies, transportation planning, transportation policy, and urban planning. ITS in transportation infrastructure and vehicles, that improve transportation safety, productivity, environment, and travel reliability. Mobile device applications of ITS such as trip planners, ETAs of public transit vehicles.

ITS functional areas – Advanced Traffic Management Systems (ATMS) , Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS). ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.

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

Course Learning Outcomes (CLO):

At the end of this course, students should be able to:

1. Understand the historical background and evolution of intelligent transportation systems (ITS).

2. Describe the role of ITS and its benefits and challenges in improving the transportation experiences of users and system managers.

3. Understand the systems engineering application in ITS and ITS architecture.

4. Appreciate the technological requirements for ITS & gain knowledge of ITS standards and specifications.

Reference Material:

- ITS e-Primer by the U.S. Department of Transportation. Available online at https://www.pcb.its.dot.gov/eprimer/default.aspx

- Kan Paul Chen, John Miles, “Recommendations for Wor ld Road Association (PIARC)” ITS Hand Book 2000.
- Sussman, J. M., “Perspective on ITS”, Artech House Publishers, 2005.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	40
3	Sessionals (May include assignments/quizzes)	30

PTE111 STRUCTURAL MATERIALS

L	T	P	Cr
2	0	2	3.0

Course Objectives: To understand the mechanism of working of supplementary cementing materials in concrete for production of high-performance concrete.

Supplementary Cementing Materials: Types of supplementary cementing materials such as fly ash, silica fume, rice husk ash, and metakaolin; their physical, chemical, mineralogical properties; Effects of these materials on the fresh properties; Strength properties; Durability properties.

Fibre Reinforced Concrete: Definition; types of fibres; Properties of fibres; Factors affecting FRC. Mixing and casting procedure; Composite materials approach; Effect of fibres on the workability, strength and durability of concretes; Applications of different types of fibres.

High Volume Fly Ash Concrete: Definition, Effect of types of fly ash in large quantities on the strength properties of concrete; Durability and abrasion resistance of HVFA; Applications of HVFA.

Self-Compacting Concrete (SCC): Definition, Advantages and disadvantages of SCC; Various mix design procedures; Tests for SCC; Applications for SCC.

High Performance Concrete: Definition of HPC; Material selection and its properties; Parameters for concrete being considered as HPC; Applications of HPC.

Polymer Concrete Composites: Definition; Types of monomers and polymers; Types of polymer concretes and their applications.

Fibre Reinforced Plastics (FRP): Types of FRP, their properties and effects on concrete elements under various loading conditions.

Use of Waste Materials and By-products: Types of waste materials and by-products such as waste glass, scrap tires, waste foundry sand, clean coal ash, etc. Effect of these materials on the various properties of mortar and concrete; Introduction of leachates from waste materials and their analysis.

Behaviour of Concrete at High Temperature: Definition of high temperature; Mechanism of concrete failure at high temperature; spalling characteristics; difference in the behaviour of normal concrete, High strength concrete and self-compacting concrete at high temperature.

High Strength steel

List of Lab Experiments:

1. Study of stress-strain curve of high strength concrete, correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture.
2. Effect of cyclic loading on steel.
3. Non-destructive testing of existing concrete members.
4. Behavior of beams under flexure, shear and torsion.
5. Effect of supplementary cementitious materials/industrial-byproducts/recycled waste additions on the properties of concrete.
6. Behaviour of FRP-retrofitted reinforced concrete members.

Course Learning Outcomes (CLO): The students will be able to:

1. conceptualize the use of supplementary cementing materials in concrete
2. understand the behaviour of properties of fly ash concrete, fibre reinforced concrete and high performance concrete
3. understand the properties of concrete made with waste materials and industrial by-products
4. conceptualize new developments in concrete technology in terms of Self compacting concrete, polymer concrete, FRP and concrete at high temperature.
5. apply engineering principles to understand behavior of structural/ elements.

Text Books:

1. *Nevelli, A. M., Properties of Concrete, Prentice Hall of India (1995)*
2. *Siddique, R., Special Structural Concretes, Galgotia Publications (2000)*

Reference Books:

3. *Krishna Raju, N., Concrete Mix Design, CBS Publications (2002)*
4. *Gambhir, M. L., Concrete Technology, Tata-McGraw Hill, 3rd Edition (2008)*
5. *Siddique, R., Waste Materials and By-products in Concrete, Springer (2008)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25

PTE208 SITE EXPLORATION & FIELD TESTING

L	T	P	Cr
1	0	4	3.0

Course Objectives: To understand the different methods of site exploration and soil testing techniques.

Need and importance of site investigations: Site exploration and phasing of site exploration programme, Spacing and depth of bore holes, significant depth

Methods of site exploration: Soundings bore holes, drilling methods and equipment wash boring, rotary boring and percussion boring in soils at stabilization of bore holes. Procuring and handling of disturbed and undisturbed samples- various types of samplers and sampling techniques, their relative merits and suitability in particular cases, lowering of water table.

Geophysical methods of soil exploration: Seismic, electrical and resistivity methods, Magnetic and gravity methods, Observation of ground water level, Different methods of ground water observation, Their merits and demerits.

Soil testing techniques: Field tests for permeability, in place density, vane shear test, plate bearing test, standard penetration test, SCPT, CPT, Pressure meter test.

Laboratory Work: Tri-axial shear test, Drained and Un-drained test, Consolidation test, unconfined compressive strength test, direct shear test. Recording and reporting of data for particular engineering use e.g. for machine foundations, earth dams etc, Discussion and seminar on published papers of recent origin connected with exploration and testing of soils, case histories of failure of structures.

Assignment /Project: Students in groups of 4 to 6 will do the projects by conducting test like SPT, PLT and lab tests, the students will determine the safe bearing capacity for various structures.

Course Learning Outcomes (CLO):

After the completion of this course the student would be able to:

1. Plan the site exploration program for the construction of various structures.
2. Procure and handle the testing of disturbed and undisturbed soil samples.
3. Perform various lab tests for prediction of shear strength of soils.
4. Perform and analyse the data from various in-situ soil testing methods.

Recommended Books and Manuals:

1. *Simons, Noel, Menzies, Bruce and Matthews, Marcus. Geotechnical Site Investigation, Thomas Telford Publishing, (2002).*
2. *Hawkins, Brian. A., Site investigation Practice, Geological Society of London, (1986).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	-
2	EST	30
3	Sessionals (May include assignments/quizzes/tutorials/Seminar/Lab Viva & File)	70

PTE110: URBAN TRANSPORTATION INFRASTRUCTURE: PLANNING AND DESIGN

L	T	P	Cr
3	0	0	3.0

Course Objectives: To enable the students to develop the concepts of Urban Transportation Infrastructure Planning and Design

History and role of Transit: Recent Trends Mass Transportation Characteristics. Demand characteristics, Spatial, Temporal and Behavioural Characteristics of Transportation Demand

Urban Mass Transportation Planning: Demand Surveys, Estimation and Demand Projection, Four Stages of Planning. Performance Evaluation of Mass Transport System, Structure of Decision Making, Evaluation and Selection Methods, Selection Procedures, Economic Evaluation Methods

Terminals and their Functions: Design, Typical Characteristics. Scheduling, Service Analysis, Vehicle Dispatch Policy, Vehicle Requirements, Spacing of Bus Troops, Route Spacing and Performance

Operational and Management Issues: Fleet Management, Reserved Bus Lanes, Signal Preemption, Dial-a-Bus, Vehicle Monitoring and Control System, Modal Coordination, Special Studies, Underground Transportation, Para transit, Rail Transit, Case Studies

Introduction to Integrated Transportation Systems

Assignment/ Project: Design & Planning of Urban Mass Transportation System.

Course Learning Outcomes (CLO):
After the completion of this course the student would be able to:

1. Design the planning for the Urban Mass Transportation Systems.
2. Design the terminals for the transportation systems.
3. Analyse the operational and management issues in mass transportation systems.

Recommended Books:

1. Vuchic V.R., Urban Public Transportation System and Technology, Prentice Hall, Inc. Englewood Cliffs, New Jersey, (2014).

2. Agarwal M.K., Urban Transportation in India, INAE, Allied Publishers Ltd., (1996).

3. Grey G.E. &Hoel , L. A., Public Transportation, Prentice Hall, Englewood Cliffs, N.J. (1992).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	40
3	Sessionals (May include assignments/quizzes)	30

PTE210: INTERSECTION DESIGN & CONTROL

L	T	P	Cr
3	0	0	3.0

Course Objective: To provide detailed knowledge of controlled and uncontrolled signal design with a focus on vehicle and pedestrian movement and To develop an in-depth understanding of the placement of traffic control devices, and alteration of existing intersection geometry.

Course Description:

Type of intersections, conflict points, introduction to traffic congestion, causes of congestion, short-term and long-term measures for mitigating traffic congestion, safety, and traffic control devices.

Traffic movement at signalized intersections, factors affecting the design of intersections, delay, saturation flow and level of service of the signal-controlled intersections, reduction of conflict points at intersections, signal co-ordination, development of a coordinated signalized corridor and signal design.

Traffic movement and driver's behaviour at unsignalized intersections, capacity and LOS of unsignalized intersections, surrogate safety measures of unsignalized intersections, and modification of existing geometric features at unsignalized intersections.

Types of roundabouts, elements of a roundabout, capacity estimation methods of a roundabout, level of service of a roundabout.

Design concepts and safety of pedestrian infrastructure at intersections, pedestrian warrants, pedestrian speed prediction model at signalized and unsignalized crossings, walkability index and LOS.

Course Learning Outcomes (CLO):

After the completion of this course the student will be able to:

1. gain hands-on experience in controlled and uncontrolled signal design and pedestrian facility design.
2. apply knowledge to develop a coordinated signalized corridor, and enhance the safety of intersections by placing traffic control devices and necessary changes in the existing geometric features.
3. Appreciate various safe intersection planning and design methods to handle real-time Traffic Related problems.

Reference Material:

1. IRC-SP-41 - Design of at Grade Intersection.
2. IRC-65 - Recommended Practice for Traffic Rotaries.

3. IRC-103 – Guidelines for Pedestrian Facilities.
4. Indo Highway Capacity Manual (HCM), 2017.
5. US Highway Capacity Manual (US HCM), 2010.
6. IRC: 67-2020- Code of Practice for Road Signs.
7. IRC: 35-2015 - Code of Practice for Road Markings.
8. IRC: 79-2019- Recommended Practice for Road Delineators.

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	30
2	EST	40
3	Sessionals (May include assignments/ quizzes/ mini projects/ presentations/)	30

PTE 211: PAVEMENT EVALUATION, REHABILITATION AND MAINTENANCE

L	T	P	Cr
3	0	0	3.0

Course Objectives: The objective of this course is to equip students with comprehensive knowledge and practical skills for evaluating, rehabilitating, and maintaining the integrity of flexible and rigid pavements. Students will gain proficiency in identifying pavement distresses, evaluating structural and functional aspects, implementing maintenance and preservation techniques, recycling strategies, and executing effective rehabilitation methods, supported by case studies.

Pavement Distresses: types, identification, causes, remedial measures for distresses in flexible and rigid pavements

Pavement Evaluation: Techniques for functional and structural evaluation of pavements (flexible and rigid); PCI and its determination; non-destructive tests; network and project survey and evaluation; pavement friction, IRI, and roughness measurement

Pavement Rehabilitation: rehabilitation techniques; overlay design procedures; whitetopping; rehabilitation with geotextiles; rehabilitation of concrete pavements

Pavement Maintenance: pavement serviceability; types of maintenance; pavement preservation techniques and their design;

Pavement Recycling: benefits; selection of pavement; hot in-place, cold in-place, in plant recycling; full depth reclamation.

Advanced topics: Pavement instrumentation; pavement management systems; pavement maintenance management; quality control/quality assurance; case studies on pavement failure investigations etc.

Course Learning Outcomes (CLO):

After the completion of this course the student will be able to:

4. Identify and assess various distresses in flexible and rigid pavements, determining their causes, severity, and treatments.
5. Understand techniques for evaluating pavement condition, including the application of tools like Pavement Condition Index (PCI) and non-destructive tests.
6. Design and implement appropriate maintenance and preservation strategies to sustain pavement serviceability and extend its lifespan.
7. Apply recycling and rehabilitation techniques effectively to restore pavement functionality and durability

Recommended Books

1. *Rajib Mallick and Tahar El-Korchi. Pavement Engineering, Fourth Edition, CRC Press, 2023.*
2. *E R Brown, P S Kandhal, F L Roberts, Y R Kim, D Y Lee. Hot Mix Asphalt Materials, Mixture Design and Construction. 3rd Edition, NAPA Education Foundation, 2023.*
3. *P S Kandhal. A Veeraragavan, R Choudhary. Bituminous Road Construction in India, PHI Learning, 2nd Edition, 2023.*
4. *C O'Flaherty, D Hughes. Highways – The Location, Design, Construction and Maintenance of Road Pavements, 5th Edition, ICE Publishing, 2015.*
5. *Norbert Delatte. Concrete Pavement Design, Construction and Performance, 2nd Edition, CRC Press, 2014.*
6. *R Hass, W R Hudson, J P Zaniewski. Modern Pavement Management, Krieger Publishing, 1994.*
7. *Federal Highway Administration. Pavement Recycling Guidelines for State and Local Governments, FHWA-SA-98-042, 1997 . https://www.fhwa.dot.gov /pavement/recycling/98042/*
8. *Asphalt Institute. Manual Series (MS-16). Asphalt in Pavement Preservation and Maintenance, 2009.*
9. *Asphalt Institute. Manual Series (MS-17). Asphalt Overlays for Highway and Street Rehabilitation, 1999.*
10. *Relevant IRC guidelines.*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	30
2	EST	40
3	Sessionals (May include assignments/ quizzes/ mini projects/ presentations/)	30