DETAIL

COURSE CURRICULUM

FOR

POSTGRADUATE PROGRAMME

M.TECH

IN

CIVIL ENGINEERING

Specialization in

TRANSPORTATION ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY AGARTALA

TRIPURA (WEST), INDIA

PIN: 799046

PREFACE

Civil Engineering Department of NIT Agartala, awards the degree of Master of Technology (M. Tech) in seven different specializations viz, Environmental Engineering, Geotechnical Engineering, Hydro-Informatics Engineering, Structural Engineering, Seismic Science and Engineering, Transportation Engineering and Water Resources Engineering.

The course structures of all post graduate degree programmes are carrying a total of 80 credits and 2000 marks. Semester wise distribution of course and credits are as follows: First semester: 25 credits and 800 marks for five theory subjects (comprises basic core, core and elective subjects), two laboratory subjects and seminar; Second semester: 25 credits and 800 marks for four theory subject (comprises basic core, core and elective subjects), two laboratory subjects, comprehensive viva-voce and project preliminaries; Third semester: 10 credits and 100 marks; and Fourth semester: 20 credits and 300 marks. Third and fourth semester of PG courses will be fully devoted to project works. Minimum requirement of number of class hours for each theory course is 40 hours per semester.

There will be continuous assessment of the performance of students throughout the semester. Each theory subject in a semester is evaluated for 100 marks, with the following weightages. Sub-component weightage: Continuous evaluation: 30 Marks (Attendance: 5 Marks, Quiz: 5 Marks, Class test: 10 Marks, Assignment: 10 Marks); Mid-semester Examination: 20 Marks; and End-semester Examination: 50 Marks

The course curriculum of M Tech Transportation Engineering programme is designed considering the following six Programme Outcomes (POs).

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: An ability to identify, formulate and solve Transportation Engineering related problems using advanced level computing techniques

PO5: An ability to understand the impact of Transportation Engineering solutions in a global, economic, environmental and societal context

PO6: Ability to demonstrate the knowledge of transportation engineering and management principles and apply these to multidisciplinary environments.

The course curriculum of M Tech Transportation Engineering programme is also designed considering two Program Specific Outcome (PSOs).

PSO1: Analysis, design, investigation of complex problems in ways which are sustainable and environmental friendly.

PSO2: Handling of any Civil Engineering projects ethically either as an individual or as a team.

Expert opinions are being taken in regular basis in order to improve the quality of teaching learning process and to attain the programme outcomes efficiently.

In the Final year of M.Tech programmes (Third and Fourth Semesters) students may also opt for industrial research. If any student desire to pursue his/her research in reputed industries, he/she may be allowed to do so, provided:

a. The selected industry is a permanent member of NASSCOM, FICCI and other such industry bodies.
b. The selected industry needs is approved by the DPPC of the concerned Department.
c. The student selects one supervisor from industry and another supervisor from the Institute.
d. If any student opts for such industrial research he/she will not receive any scholarship from the institute in this tenure, even if he/she wants to return back. In such cases the student will be allowed to complete his/her project in the institute but without any scholarship.

CONTENT

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Syllabus: M.Tech. (Transportation Engineering)

FIRST SEMESTER		No. of Classes/Week			Total Credits	Marks
Sl. No.	**Subject**	**Lecture**	**Tutorial**	**Practical**		
1	**Basic Core** PCE31B01:Pavement Materials	03	01	00	4	100
2	**Core Subject-I** PCE31C01:Urban Transportation Planning and Management	03	01	00	4	100
3	**Core Subject-II** PCE31C02:Traffic Engineering Operation & Management	03	01	00	4	100
4	**Elective Paper-I (Any One)** PCE31E01:Advanced Mathematics PCE31E02: Traffic Safety PCE31E03: Highway Construction Practice PCE31E04: Airport Planning & Design	03	01	00	4	100
5	**Elective Paper-II (Any One)** PCE31E05: Intelligent Transportation System PCE31E06: Geographical Information System & its application PCE31E07: Mechanics of Soil PCE31E08: Railway Transportation System	03	01	00	4	100
6	PCE31P01: Pavement Engineering Laboratory-I	00	00	03	2	100
7	PCE31P02: Traffic Engineering Laboratory	00	00	03	2	100
8	PCE31P03: Seminar	00	00	02	1	100
	Total	**15**	**05**	**08**	**25**	**800**

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SECOND SEMESTER		No. of Classes/Week			Total Credits	Marks
Sl. No.	**Subject**	**Lecture**	**Tutorial**	**Practical**		
1	**Basic Core** PCE32B01:Analysis & Design of Pavements	03	01	00	4	100
2	**Elective Paper-III (Any One)** PCE32E01:Geometric Design of Transportation Facilities PCE32E02: Ecology & Environmental Impact Assessment PCE32E03: Geo-environmental Engineering	03	01	00	4	100
3	**Elective Paper-IV (Any One)** PCE32E01: Bridge Engineering PCE32E02: Pavement Evaluation, Rehabilitation and Maintenance. PCE32E03: Urban Mass Transit Planning, Operations and Management	03	01	00	4	100
4	**Elective Paper-V (Any One)** PCE32E04: Ground Improvement Technique PCE32E05: Finite Element Method PCE32E06: Advanced Traffic Engineering	03	01	00	4	100
5	PCE32P01: Project Preliminaries	00	00	04	4	100
6	PCE32P02: Pavement Engineering Laboratory-II	00	00	04	2	100
7	PCE32P03: Computer Oriented Design Lab	00	00	04	2	100
8	PCE32P04: Comprehensive Viva-voce	00	00	00	1	100
	Total	**12**	**04**	**12**	**25**	**800**

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THIRD SEMESTER		No. of Classes/Week			Total Credits	Marks
Sl. No.	**Subject**	**Lecture**	**Tutorial**	**Practical**		
1	PCE33P01: Project & Thesis - I	00	00	Full	10	100
	Total	**00**	**00**	**Full**	**10**	**100**

FOURTH SEMESTER		No. of Classes/Week			Total Credits	Marks
Sl. No.	**Subject**	**Lecture**	**Tutorial**	**Practical**		
1	PCE34P01: Project & Thesis - II	00	00	Full	20	300
	Total	**00**	**00**	**Full**	**20**	**300**

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SYLLABUS FOR M.TECH (Transportation Engineering)

FIRST SEMESTER

Sl. No.	Subject Code	Name of the Subject	L	T	P	Total Periods/ week	Credit	Marks
01	PCE31B01	Pavement Materials	03	01	×	04	4	100
02	PCE31C01	Urban Transportation Planning and Management	03	01	×	04	4	100
03	PCE31C02	Traffic Engineering Operation & Management	03	01	×	04	4	100
04	PCE31E01-04	Elective Paper-I	03	01	×	04	4	100
05	PCE31E05-08	Elective Paper-II	03	01	×	04	4	100

Practical/Sessional

Sl. No.	Subject Code	Name of the Subject	L	T	P	Total Periods/ week	Credit	Marks
06	PCE31P01	Pavement Engineering Lab-I	00	00	03	03	4	100
07	PCE31P02	Traffic Engineering Laboratory	00	00	03	06	4	100
08	PCE31P03	Seminar I	00	00	01	02	1	100

Pavement Materials

(PCE31B01)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To study the types of material and their properties available for the construction of pavements.
2. To understand the behaviour of binders and their importance as a pavement material before and after mixing with other ingredient material.
3. To execute the importance of paving concrete, their behavior during life and after life as recycles material.
4. To be appraise the different techniques used for soil improvement, use of different material during improvement of soil etc.

Course Content:

Unit-1

Classification of soil, soil strength parameters, compaction consolidation, various tests of soil properties for highway design; Classification, properties of aggregates, design of aggregate gradation.

Unit-2

Bituminous binder- Penetration grade, emulsions, cutback and modified binders. Rheology of bituminous binders, modified binders.

Bituminious Mix design. Marshall Method and Superpave procedure; Design of emulsified mixes, Visco-elastic and fatigue properties of bituminous mixtures, resilient modulus of pavement materials.

Unit-3

Requirements of paving concrete, design of mixes for recycling of bituminous and concrete pavement surfaces.

Unit-4

Soil stabilization techniques; Use of alternative material – fly ash, rice husk, geotextiles etc.

Course Outcome:

1. Students will be able to enumerate the types and quality of different material required for pavement construction (K1).
2. Students will be able to describe the requirement of binders in paving mix, their importance in mix design etc. They will also learn the techniques of different mix design procedures (K2).
3. Students will be able to illustrate the paving concrete, re-use of materials when the lifecycle of the material is over (K3).
4. Students will be able to formulate the different soil stabilization techniques. They will be expert in choosing different material useful for soil improvement required for better pavement construction (K6).

To establish the correlation between COs & POs

Table- 1

No. of Course Outcome (CO)	Course Outcome
PCE31B01.1	Students will be able to enumerate the types and quality of different material required for pavement construction.
PCE31B01.2	Students will be able to describe the requirement of binders in paving mix, their importance in mix design etc. They will also learn the techniques of different mix design procedures.
PCE31B01.3	Students will be able to illustrate the paving concrete, re-use of materials when the lifecycle of the material is over.
PCE31B01.4	Students will be able to formulate the different soil stabilization techniques. They will be expert in choosing different material useful for soil improvement required for better pavement construction.

Table 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE31B01.1	3	3	2	3	2	3
PCE31B01.2	2	3	3	3	2	3
PCE31B01.3	3	3	2	3	2	3
PCE31B01.4	2	3	2	3	2	3
Total	**10**	**12**	**9**	**12**	**8**	**12**
Average	**2.5**	**3**	**2.25**	**3**	**2**	**3**
Eq. Av Attainment	**3**	**3**	**2**	**3**	**2**	**3**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE31B01.1	3	3
PCE31B01.2	3	3
PCE31B01.3	3	3
PCE31B01.4	3	3
Total	**12**	**12**
Average	**3**	**3**
Eq. Avg Attainment	**3**	**3**

Reference:

Sl. No.	Name of Books	Author	Publisher
1	Highway construction and Maintenance	Martin	Blackwell Science
2	Highway Material Testing	Khanna & Justo	Nem Chand Bros
3	Modern Pavement Management	Haas, R., Zaniewski,W.R.	Krieger Publishing, Hudson, J.P. company
4	Standard specification for Transportation Material & Method of sampling & Testing Engineering	AASHTO	AASHTO

Urban Transportation Planning and Management

(PCE31C01)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To understand the principles and practices of transportation engineering and urban transportation planning.
2. To introduce travel survey method for understanding travel behaviour.
3. To introduce the key concepts of the urban transportation planning system.
4. To introduce the fundamental concepts of public transport system such as system, technology and quality of service.
5. Have the capability to identify and solve transportation problems within the context of data availability and limitations of analysis tools.

Course Content:

Unit-1

Urban Transportation Problems & Policy:

Urban transportation Issues, Travel Characteristics, Evolution of Planning Process, Systems approach to urban transportation planning concepts; flow chart for transportation planning process.

Unit-2

Travel Demand Modelling:

Travel Attributes, Assumptions in Demand Estimation, Aggregate and Disaggregate Techniques, Activity based models.

Unit-3

Data Collection and Inventories:

Data needs for planning process, Use of secondary data. Definition of the study area. Cordon line, screen line, Zoning, sample size determination, Data collection techniques. O-D surveys.

Unit-4

Travel Demands Forecasting:

Travel demand estimation; Trip generation analysis-Aggregate analysis, dis-aggregate analysis, Regression analysis. Types of regression models-linear, non-linear, multiple regression models. Category analysis. Trip distribution analysis. Growth models- Fratar and Furness models. Various forms of the gravity models, Modal split analysis, Modelling travel behaviour. Aggregate and Dis-aggregate Models, Probabilistic models- probit and logit models. Trip assignment models. Minimum path assignment. All or nothing assignment, Capacity restrained assignment.

Unit 5 - Land Use and Transportation

Urban land use planning- land use and land cover, Land use transportation interaction; Accessibility and mobility, Land use models.

Unit-6

Introduction to Urban Freight Transportation and Urban Mass Transportation Systems.

Course Outcome:

1. To identify the issues of transportation planning and transportation policy (K3)
2. To be able to apply the knowledge to supervise the process of data collection about travel behavior and analyze the data for use in transportation planning. (K3)
3. Develop and calibrate modal spit, trip generation rates for specific types of land use developments. (K6)
4. Prepare urban transportation plans. (K6)

To establish the correlation between COs & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE31C01.1	To identify the issues of transportation planning and transportation policy
PCE31C01.2	To be able to apply the knowledge to supervise the process of data collection about travel
PCE31C01.3	Develop and calibrate modal split, trip generation rates for specific types of land use developments
PCE31C01.4	Prepare urban transportation plans

Table-2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE31C01.1	3	2	3	2	3	3
PCE31C01.2	3	2	3	2	3	3
PCE31C01.3	3	2	3	2	3	3
PCE31C01.4	3	2	3	2	3	3
Total	**12**	**8**	**12**	**8**	**12**	**12**
Average	**3**	**2**	**3**	**2**	**3**	**3**
Eq. Av Attainment	**3**	**2**	**3**	**2**	**3**	**3**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE31C01.1	4	3
PCE31C01.2	4	3
PCE31C01.3	4	3
PCE31C01.4	4	3
Total	**16**	**12**
Average	**4**	**3**
Eq. Avg Attainment	**4**	**3**

Reference:

1. J. de D. Ortuzar and L.G. Willumsen, Modelling Transport, John Wiley and Sons,2001.
2. C.J. Khisty and B.K. Lall, Transportation Engineering – An Introduction, Prentice Hall of India Pvt. Ltd., 2002.
3. C. S. Papacostas and P. D. Prevedouros, Transportation Engineering and Planning, Prentice Hall of India Pvt. Ltd., 2001.
4. Transit Capacity and Quality of Service Manual, 2nd Edition, Transportation Research Board

Traffic Engineering Operation & Management

(PCE31C02)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To understand the importance of traffic engineering including the knowledge of basic parameters viz. Speed, volume, density and their relationship.
2. To study the various procedure of traffic survey.
3. To implement the proper parking slots of vehicles in a city.
4. To create proper management system and operation of traffic in a city.

Course Content:

Unit-1

Traffic Engineering and its importance in development of a country; Traffic Flow parameters Relationship– speed, volume, density, capacity.

Unit-2

Traffic Survey – speed, journey time, delay studies; Vehicle volume counts, classification and occupancy; Origin & destination survey-need for O-D survey, survey methods; Statistical analysis and interpretation of traffic studies -- sampling theory and significance testing, linear regression and correlation, Multiple Linear Regression.

Unit-3

Parking and Parking Survey – Types of parking- on- street and off-street parking; Need for parking surveys, parking space inventory, parking usage survey by patrol, cordon count;

Traffic Forecasting – need for traffic forecasting, limitation of traffic forecasting, forecasts and mathematical models.

Unit-4

Traffic management and operation -- Traffic signs and signals, Need for Signalization, Hierarchy of Intersection Control: Basic Rules of Road, STOP and YEILD Signs, Traffic Signalization. Warrants for Traffic signals, Components of Signal Cycle. Types of Signal Operation: Pre-Timed, Semi-Actuated and Full- Actuated Operation.

Street lighting, road markings and traffic control aids and street furniture.

Course Outcome:

1. Students will be able to study the importance of traffic engineering including the knowledge of basic parameters viz. Speed, volume, density and their relationship. (K2)
2. Students will be able to know the various procedure of traffic survey including regression analysis. (K2)
3. Students can implement the proper parking slots of vehicles in a city. (K3)
4. Students can create proper management system and operation of traffic in a city. (K6)

To establish the correlation between COs & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE31C02.1	Students will be able to study the importance of traffic engineering including the knowledge of basic parameters viz. Speed, volume, density and their relationship
PCE31C02.2	Students will be able to know the various procedure of traffic survey including regression analysis
PCE31C02.3	Students can implement the proper parking slots of vehicles in a city.
PCE31C02.4	Students can create proper management system and operation of traffic in a city

Table 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE31C02.1	3	3	3	2	3	3
PCE31C02.2	3	3	3	2	3	3
PCE31C02.3	3	3	3	2	3	3
PCE31C02.4	3	3	3	2	3	3
Total	**12**	**12**	**12**	**8**	**12**	**12**
Average	**3**	**3**	**3**	**2**	**3**	**3**
Eq. Av Attainment	**3**	**3**	**3**	**2**	**3**	**3**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE31C02.1	4	4
PCE31C02.2	4	4
PCE31C02.3	4	4
PCE31C02.4	4	4
Total	**16**	**16**
Average	**4**	**4**
Eq. Avg Attainment	**4**	**4**

References:

Sl. No.	Name of Books	Author	Publisher
1	Fundamentals of traffic engineering	C.S Papacostas	Prentice-Hall
2	Traffic Engineering and Transport Planning	L.R . Kadiyali	Khanna Publisher
3.	Traffic Engineering	Roger P Roess, Elena S Prassas	Prentice Hall
4.	Principles of Transportation Engineering	P. Chakraborty & A. Das	Prentice Hall

ELECTIVE PAPER- I

Advance Mathematics

(PCE31E01)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1 Introduce students to ordinary differential equations and the methods for solving these equations Use differential equations as models for real world phenomena.
2 Integrate the knowledge accumulated in the calculus sequence to solve applied problems.
3 Introduce the fundamentals of Linear Algebra and Complex Analysis.
4 Provide a rigorous introduction to upper level mathematics which is necessary for students of engineering, physical sciences and mathematics.

Course Content:

Unit-1

Calculus of Variations – Variation and its properties – Euler's equation – Conditional extreme – Isoperimetric problems – Functional dependant on first and higher order derivatives – Functional dependent on functions of several independent variables – some applications – Direct methods – Ritz and Kantorovich methods, Euler's finite difference method.

Unit-2

Laplace Transforms and Fourier Transforms. Application of Fourier Transform in solving initial and boundary value problems. Laplace Equation, Heat equation and wave equation.

Unit-3

Hankel's Transform, elementing properties of Hankel transforms, Hankel inversion and transform theorems. Hankel transforms of derivatives of functions. Parsevel's theorem. Hankel transforms of $\frac{d^2 f}{dx^2} + \frac{1}{x}\frac{df}{dx} = \frac{n^2}{x^2} f$.

Unit-4

Simulation – Types, case studies in various fields using simulation techniques, simulation softwares used, use of mathematical models based on probabilistic and statistical methods.
Partial Differential Equations – Formation of PDE, Solutions of PDE, Equations solvable by direct integration, Linear equations of the first order, Non-linear equations of the first order, Charpit's Method,
Homogeneous Linear equations with constant coefficient, Non-Homo geneous Linear equations, Non-Linear equations of the second order.

Unit-5

Solution of Parabolic and Hyperbolic equations – Implicit and Explicit Schemes, ADI methods, Non Linear parabolic equations – Iteration method, Solution of elliplic equation – Jacobi method, Gauss - Seidel & SOR method. Richardson method, RKF4.

Unit-6

Introduction to finite element method and its scope.

Course Outcome:

1 To utilize various methods for solving ODEs and solve initial value problems, understand the existence and uniqueness of such solutions and to Recognize ODEs of varying order and use these to solve problems involving population dynamics, oscillation of a spring and resistance in a circuit
2 Ability to Work with and solve homogeneous and non-homogeneous ODEs and systems of ODEs. Moreover, to learn additional methods for solving ODEs including Euler's method, the power series method and Laplace transforms.
3 Perform basic operations with matrices, find the inverse of a matrix, determinant of a square matrix, as well as eigen values and eigen vectors and investigate associated applications, and to use matrices to solve systems of equations.
4 Express complex numbers in trigonometric and polar form, and to perform operations with complex numbers, including finding the roots of unity.
5 Explore functions of a single complex variable and calculate derivatives of analytic functions
6 Calculate line integrals in the complex plane, and Study Cauchy-Riemann equations, Cauchy's integral theorem and Cauchy's integral formula.

Table 1: To establish the correlation between COs & POs

No. of Course Outcome (CO)	Course Outcome
PCE31E01.1	To utilize various methods for solving ODEs and solve initial value problems, understand the existence and uniqueness of such solutions and to Recognize ODEs of varying order and use these to solve problems involving population dynamics, oscillation of a spring and resistance in a circuit
PCE31E01.2	Ability to Work with and solve homogeneous and non-homogeneous ODEs and systems of ODEs. Moreover, to learn additional methods for solving ODEs including Euler's method, the power series method and Laplace transforms.
PCE31E01.3	Perform basic operations with matrices, find the inverse of a matrix, determinant of a square matrix, as well as eigen values and eigen vectors and investigate associated applications, and to use matrices to solve systems of equations.
PCE31E01.4	Express complex numbers in trigonometric and polar form, and to perform operations with complex numbers, including finding the roots of unity.
PCE31E01.5	Explore functions of a single complex variable and calculate derivatives of analytic functions
PCE31E01.6	Calculate line integrals in the complex plane, and Study Cauchy-Riemann equations, Cauchy's integral theorem and Cauchy's integral formula

Table 2

Slight (Low): 1; Moderate: 2; Substantial (High):3; No Correlation: - "- "

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE31E01.1	3	3	2	3	2	3
PCE31E01.2	2	2	2	3	2	2
PCE31E01.3	3	2	3	3	2	2
PCE31E01.4	3	3	2	3	2	3
PCE31E01.5	2	2	2	3	2	3
PCE31E01.6	3	2	1	3	2	2
Total	**16**	**14**	**12**	**18**	**12**	**15**
Average	**2.67**	**2.33**	**2**	**3**	**2**	**2.5**
Eq. Av Attainment	**3**	**2**	**2**	**3**	**2**	**3**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE31E01.1	4	3
PCE31E01.2	4	3
PCE31E01.3	4	3
PCE31E01.4	4	3
PCE31E01.5	4	3
PCE31E01.6	4	3
Total	**24**	**18**
Average	**4**	**3**
Eq. Avg Attainment	**4**	**3**

References:

1. Kreyszig Erwin, Advanced Engineering Mathematics, John Wiley & Sons (Asia) Pvt Ltd.
2. Krishnamurthy & Sen, Numerical Algorithms, Afiliated East-west press private Limited, New Delhi.
3. Ramana, B. V., Higher Engineering Mathematics, The McGraw-Hill Companies, New-Delhi

Traffic Safety

(PCE31E02)

Total Credits	**04**	**L – T – P**	**3 – 1 – 0**

Course Objective:

1. Understanding the road safety issues
2. Analyzing factors causing crashes and countermeasures
3. Understanding the principles of road safety audit

Course Content:

Unit -1

Highway functions; highway safety: road, vehicle and human factors in crashes, Vehicle and Human Characteristics; Vehicle related characteristics; human factors; Non-motorist road users; Engineering Components; Road design standards; pavement properties.

Unit-2

Planning of road network, land use and road environment for safety, road link design for safety. Safety Analysis: Statistical Models, Road crashes: causes, assessment of high collision sites, collision diagram, crash factor matrix, preliminary report, crash summary report accident forensic investigation, accident reconstruction; expert witness analysis; field studies; safety enhancement projects.

Unit-3

Human factors approach: Forgiving designs, safety issues of vulnerable road users: bicycle/pedestrian safety and traffic control devices for safety; safety issues in public transport; bus stops and bus bays; Night time driving: visibility, road lighting and retro-reflectivity of signs and markings; Safety at Construction zones; Enforcement and regulations.

Unit -4

Speed Management & safety, Safe systems and the role of speed, Benefits of speed management, tools for managing speed, Design of speed management system.

Unit -5

Traffic Safety Audits: introduction; description; significance; Institutional framework; Case studies; Field visit; Data and its significance: crash data, traffic data, planning data, design data; Crash analysis: temporal and spatial distributions; Problem identification and selection of countermeasures: engineering, enforcement and educational treatments; Feasibility; Evaluation of safety improvement projects: mathematical and statistical techniques; Case studies.

Course Outcome:

1. Design different highway facilities and apply relevant highway design standards (K6)
2. Analyze crash and traffic data employing the appropriate statistical techniques (K5)
3. Conduct traffic safety studies, identify high-accident locations, and propose crash countermeasure and potential engineering solutions. (K6)
4. Conduct crash investigation and expect witness analysis (K6)

To establish the correlation between COs & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE31E02.1	Design different highway facilities and apply relevant highway design standards
PCE31E02.2	Analyze crash and traffic data employing the appropriate statistical techniques
PCE31E02.3	Conduct traffic safety studies, identify high-accident locations, and propose crash countermeasure and potential engineering solutions
PCE31E02.4	Conduct crash investigation and expect witness analysis

Table- 2

1. **Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"**

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE31E02.1	3	3	3	2	3	3
PCE31E02.2	3	3	3	2	3	3
PCE31E02.3	3	3	3	2	3	3
PCE31E02.4	3	3	3	2	3	3
Total	**12**	**12**	**12**	**8**	**12**	**12**
Average	**3**	**3**	**3**	**2**	**3**	**3**
Eq. Av Attainment	**3**	**3**	**3**	**2**	**3**	**3**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE31E02.1	4	3
PCE31E02.2	4	3
PCE31E02.3	4	3
PCE31E02.4	4	3
Total	**16**	**12**
Average	**4**	**3**
Eq. Avg Attainment	**4**	**3**

References:

1. Kadyali, L.R., Traffic Engineering and Transport Planning, Khanna Publications, New Delhi5.
2. Latest Editions of Relevant Indian Roads Congress (IRC) Publications for Geometric Design and Road Safety.

Highway Construction Practice

(PCE31E03)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To study the technique of construction of Embankments, formation and other types of road subgrade, Sub base, Base course.
2. To implement the construction of different bituminous layers of pavement along with use of equipment's.
3. To experiment the use of concrete road and other nonconventional material, recycle material etc. in pavement construction and the details of contract with the firms.
4. To formulate the quality control of different construct techniques of hill roads.

Course Content:

Unit-1

Embankment Construction: Formation cutting in Soil and hard rock, Preparation of Subgrade, Application of Ground improvement techniques, Retaining and Breast walls on hill roads, Granular and Stabilized, Sub – bases / bases, Construction of Water Bound Macadam (WBM) / Wet Mix Macadam (WMM) / Cement treated bases / Dry Lean Concrete (DLC), Road Construction Equipment's;

Unit-2

Bituminous Constructions: Types of Bituminous Constructions, Interface Treatments, Bituminous Surfacing and wearing Courses for roads and bridge deck slabs, Selection of wearing Course under different Climatic and Traffic conditions, IRC specifications, Construction techniques and Quality Control, Details of Contracts;

Unit-3

Concrete road construction: Test on Concrete mixes, Construction equipment's, Method of construction of joints in concrete pavements, Quality Control in Construction of Concrete pavements, Construction of Continuously reinforced, Prestressed, Steel Fibre Reinforced (SFRC) Pavements, IRC, MORT&H, ACI Specifications, AASHTO Specifications, Recycled pavements, Non – Conventional Pavements, Overlay Construction.

Unit-4

Hill Roads Construction: Stability of Slopes, Landslides – Causes and Control measures, Construction of Bituminous and Cement Concrete roads at high altitudes, Hill road drainage, Construction and maintenance problems and remedial measures.

Course Outcome:

1. Students will be able to associate with the construction of subgrade in embankment, cutting and plain terrain (K2).

2. Students will be able to compose the different structural layers of road pavement (K6).

3. Students will be able to solve the problem of shortage of conventional materials for road and other road related structures (K3).

4. Students will be able to discuss the use of various equipments in road construction along with quality control techniques (K2).

To establish the correlation between COs & POs

Table 1

No. of Course Outcome (CO)	Course Outcome
PCE31E06.1	Students will be able to associate with the construction of subgrade in embankment, cutting and plain terrain, Sub base and base preparation.
PCE31E06.2	Students will be able to compose the different bituminous layers of road pavement. They will be able to understand the contract details.
PCE31E06.3	Students will be able to solve the problem of shortage of conventional materials for road and other road related structures. They will also be able to construct different concrete roads.
PCE31E06.4	Students will be able to discuss the use of various road construction techniques during hill road construction.

Table 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3
PCE31B01.1	3	3	2
PCE31B01.2	3	3	3
PCE31B01.3	3	3	3
PCE31B01.4	2	3	2
Total	**11**	**12**	**10**
Average	**2.75**	**3**	**2.5**
Eq. Av Attainment	**3**	**3**	**3**

Table 3 To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE31B01.1	4	4
PCE31B01.2	4	4
PCE31B01.3	4	4
PCE31B01.4	4	4
Total	**16**	**16**
Average	**4**	**4**
Equivalent Avg. Attainment	**4**	**4**

Reference:

Sl. No.	Name of Books	Author	Publisher
1.	Highway construction and Maintenance	Martin	Blackwell Science
2.	Highway Material Testing	Khanna & Justo	Nem Chand Bros
3.	Modern Pavement Management	Haas, R., Zaniewski,W.R.	Krieger Publishing, Hudson, J.P. Company
4.	Standard specification for Transportation Material & Method of sampling & Testing Engineering	AASHTO	AASHTO
5.	MoRTH	MoRTH	IRC

Airport Planning and Design

(PCE31E04)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To study the types of types of aircraft, their obstructions during movement and their operation.
2. To execute the design and orientation of runways and taxiways.
3. To evaluate the different facilities required in terminal building and in ground.
4. To design the different types of pavement, drainage facilities etc required for airport.

Course Content:

Unit-1

Aircraft characteristics; obstruction criteria; air traffic control; noise pollution, operations and scheduling.

Unit-2

Terminal building functional areas and facilities; planning and site selection; Ground transportation facilities.

Unit-3

Runways: orientation, length, geometric standards, capacity, configuration; taxiway: geometric standards, fillets, high speed exit taxiway; apron-gate area and circulation.

Unit-4

Pavement design and evaluation; visual aids; drainage; heliports, Airport capacity and delays.

Course Outcome:

1. Students will be able to describe the types of aircraft, different types of obstruction for aircraft and the control of air traffic movement (K1).
2. Students will be able recommend the different facilities required in the terminal building as well as in ground transport facilities (K5).
3. Students will be able to design the runways and taxiways along with their suitable orientation (K6).
4. Students will be able to design and construct the different types of pavement for aircraft, drainage facilities for airport etc (K6).

To establish the correlation between Cos & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE31E04.1	Students will be able to describe the types of aircraft, different types of obstruction for aircraft and the control of air traffic movement.
PCE31E04.2	Students will be able recommend the different facilities required in the terminal building as well as in ground transport facilities.
PCE31E04.3	Students will be able to design the runways and taxiways along with their suitable orientation.
PCE31E04.4	Students will be able to design and construct the different types of pavement for aircraft, drainage facilities for airport etc.

Table 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE31E04.1	3	3	3	3	2	3
PCE31E04.2	2	3	2	3	2	3
PCE31E04.3	3	3	3	3	2	2
PCE31E04.4	2	3	3	3	2	3
Total	**10**	**12**	**11**	**12**	**8**	**11**
Average	**2.5**	**3**	**2.75**	**3**	**2**	**2.75**
Eq. Avg. Attainment	**3**	**3**	**3**	**3**	**2**	**3**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE31E04.1	4	4
PCE31E04.2	4	4
PCE31E04.3	4	4
PCE31E04.4	4	4
Total	**16**	**16**
Average	**4**	**4**
Eq. Avg Attainment	**4**	**4**

Reference:

Sl. No.	Name of Books	Author	Publisher
1.	Planning & Design of Airports	Robert Horenjoff	McGraw Hill Professional
2.	Airport Planning & Design	Khanna, Arora, Jain	Nem Chand Bros
3.	Airport Engineering	Rangwala	Charotar Book Publishing
4.	Airport Engineering	Normal J. Ashford	John – Willey

ELECTIVE PAPER-II

Intelligent Transportation Systems

(PCE31E05)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To describe the role and responsibilities of ITS system, different uses of ITS.
2. To organize the structure of ITS framework using different tools.
3. To implement the recent advancement in the field of transportation engineering.
4. To formulate the business opportunities using the advance tools in the field of transportation engineering.

Course Content:

Unit-1

Definition –Role and Responsibilities –Advanced Traveller Information System –Fleet Oriented ITS Services – Electronic Toll Collection –Critical issues–Security –Safety.

Unit -2

Architecture –ITS Architecture Framework –Hardware Sensors –Vehicle Detection –Techniques –Dynamic Message Sign –GPRS –GPS –Toll Collection. Video Detection –Virtual Loop -Cameras -ANPR –IR Lighting – Integrated Traffic Management –Control Centre –Junction Management Strategies.

Unit -3

ATMS –Route Guidance –Issues -Travel Information –Pre Trip and Enroute Methods –Historical –Current – Predictive Guidance –Data Collection –Analysis –Dynamic Traffic Assignment (DTA) –Components – Algorithm.

Unit -4

Basic ATIS Concepts –Smart Route System –Data Collection –Process –Dissemination to Travelers –Evaluation of Information –Value of Information –Business Opportunities.

Course Outcome:

1. Students will be able to understand the different uses of ITS (K2).
2. Students will be able to apply different techniques for better management of traffic in normal roads as well as in tool collecting places (K3).
3. Students will be able to analyze the different traffic assignments using algorithm (K4).
4. Students will be able to evaluate the business opportunities using smart route system (K5).

To establish the correlation between COs & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE31E05.1	Students will be able to understand the different uses of ITS.
PCE31E05.2	Students will be able to apply different techniques for better management of traffic in normal roads as well as in tool collecting places.
PCE31E05.3	Students will be able to analyze the different traffic assignments using algorithm.
PCE31E05.4	Students will be able to evaluate the business opportunities using smart route system.

Table 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE31E05.1	3	3	2	3	2	3
PCE31E05.2	3	3	3	3	2	3
PCE31E05.3	2	3	3	3	3	3
PCE31E05.4	3	3	2	3	2	3
Total	**11**	**12**	**10**	**12**	**9**	**12**
Average	**2.75**	**3**	**2.5**	**3**	**2.25**	**3**
Eq. Avg. Attainment	**3**	**3**	**3**	**3**	**2**	**3**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE31E05.1	3	4
PCE31E05.2	3	4
PCE31E05.3	3	4
PCE31E05.4	3	4
Total	**12**	**16**
Average	**3**	**4**
Eq. Avg Attainment	**3**	**4**

Reference:

Sl. No.	Name of Books	Author	Publisher
1	Data Base System Concepts	Henry F.Korth, Abraham Siberschatz	McGraw Hill
2	Decision Support and Export Systems Management Support Systems	E.Turban	Maxwell Macmillan
3	Decision Support Systems –Tools and Techniques	Sitausu S.Mittra	John Wiley
4	Decision Support Systems –Theory and Application	Cycle W.Halsapple, Andrew B.Winston	Springer Verlog

Geographical Information System & Its Application

(PCE31E06)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To understand the concept of GIS including the knowledge of basic components and commercial use of GIS.
2. To study the process of data input and its interpolation technique.
3. To analyse different types of data and its presentation.
4. To apply GIS in different types of fields for proper detection.

Course Content:

Unit-1

Introduction - Information systems, spatial and non- spatial information, Geographical concepts and terminology, Advantages of GIS. Basic components of GIS, Commercially available GIS hardware & software, organisation of data in GIS.

Unit-2

Input data - Field data, Statistical data, Maps, Aerial photographs, Satellite data, Points, lines and areas features, Vector and Raster data, Advantages and Disadvantages, Data entry through keyboard, digitizers and scanners, Digital data. Pre-processing of data -Rectification and registration, Interpolation techniques.

Unit-3

Data Management - Data Base Management System (DBMS), Various data models, Run -length encoding, Quadtrees, Data Analysis - Data layers, analysis of spatial and non-spatial data, Data overlay and modelling. Data Presentation - Hardcopy devices, softcopy devices.

Unit-4

Applications of GIS in Map Revision, Land use, Agriculture, Forestry, Archaeology, Municipal, Geology Water Resources, Soil Erosion, Land suitability analysis, Change detection.

Course Outcome:

1. Students will be able to recognize the concept of GIS including the knowledge of basic components and commercial use of GIS. (K1)
2. Students will be able to interpret the process of data input and its interpolation technique. (K2)
3. Students will be able to apply GIS in different types of fields for proper detection. (K3)
4. Students will able to analyse different types of data and its presentation. (K4)

To establish the correlation between COs & POs

Table -1

No. of Course Outcome (CO)	Course Outcome
PCE31E06.1	Students will be able to recognize the concept of GIS including the knowledge of basic components and commercial use of GIS.
PCE31E06.2	Students will be able to interpret the process of data input and its interpolation technique.
PCE31E06.3	Students will be able to apply GIS in different types of fields for proper detection.
PCE31E06.4	Students will able to analyse different types of data and its presentation.

Table 2

Slight (Low): 1 **Moderate: 2** **Substantial (High): 3** **No Correlation: "-"**

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE31E06.1	3	2	2	2	3	2
PCE31E06.2	3	2	2	2	3	3
PCE31E06.3	3	2	2	2	3	2
PCE31E06.4	3	2	2	2	3	3
Total	**12**	**8**	**8**	**8**	**12**	**10**
Average	**3**	**2**	**2**	**2**	**3**	**2.5**
Eq. Av Attainment	**3**	**2**	**2**	**2**	**3**	**3**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE31E06.1	3	4
PCE31E06.2	3	4
PCE31E06.3	3	4
PCE31E06.4	3	4
Total	**12**	**16**
Average	**3**	**4**
Eq. Avg Attainment	**3**	**4**

References:

Sl. No.	Name of Books	Author	Publisher
1	Principles of Geographic Information System for Land Resources Assessment	Burrough, P.A	Claredon Press, Oxford, 1988
2	Introduction to Remote Sensing	Campbell, J. B.	The Guilford Press, London, 1986
3	Remote Sensing in Hydrology	Engaman, E.T., Chapman and Gurney, R.J	Hall, London 1991
4	Remote Sensing & Geographic Information Systems	Legg, C.A.	Ellis Horwood, London. 1992.

Mechanics of Soil

(PCE31E07)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To understand clay mineralogy of soil.
2. To know the basic fundamental of soil mechanics.
3. To understand the capillary phenomenon/permeability and flow behaviour of soil.
4. To know the field application based on compaction for geotechnical problems
5. To understand the application of consolidation to geotechnical problem
6. To understand the compressibility behaviour of saturated/unsaturated soil.

Course Content:

Unit-1

Introduction, formation of soil, clay mineralogy, structures of common clay minerals. Identification and classification of soil, soil weight volume relationship, index properties of soils, surface tension and capillary phenomenon. Measurement of capillary rise in soil, soil moisture, soil-water potential, measurement of soil-water potential. Mechanism of swelling potential and pressure.

Unit-2

Soil compaction, standard and modified Proctor compaction, theories of soil compaction; compaction control in field. Permeability, Darcy's law, Theories of wells, flow nets and their properties, seepage flow net in dams, flow net by relaxation method, seepage forces, uplift, piping phenomenon, problems.

Unit-3

Consolidation of soils, Introduction, Terzaghis theory of one dimensional consolidation, application to geotechnical problems. Two and three dimensional consolidation of soils, secondary consolidation.

Unit-4

Shear strength of soils; unsaturated soil Skempton pore pressure theory, compressibility of unsaturated soil, Rowes stress dilatancy theory.

Different shear parameters; special consolidation and shear tests, application to geotechnical problems.

Unit-5

Elastic stresses in soil; Stress-strain behaviour of soils; Mohr Circle of Stress; Principal Stresses. Stress distribution in homogeneous, non-homogeneous, layered and anisotropic deposits. Effect of non-linearity. Review of classical earth pressure theories and trial wedge method for c-φ soils; Stability of slopes; stability number, method of slices.

Course Outcome:

1. Students will be able to understand the clay mineralogy of soil.
2. Students will be able to understand the basic fundamental of soil mechanics.
3. Students will be able to understand the capillary phenomenon/permeability and flow behaviour of soils.
4. Students will be able to understand the field application based on compaction for geotechnical problem
5. Students will be able to understand the application of consolidation to geotechnical problem
6. Students will be able to understand the compressibility behaviour of saturated/unsaturated soil.

To establish the correlation between COs & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE31E07.1	Students will be able to understand the clay mineralogy of soil.
PCE31E07.2	Students will be able to understand the basic fundamental of soil mechanics
PCE31E07.3	Students will be able to understand the capillary phenomenon/permeability and flow behaviour of soils.
PCE31E07.4	Students will be able to understand the field application based on compaction for geotechnical problem.
PCE31E07.5	Students will be able to understand the application of consolidation to geotechnical problem
PCE31E07.6	Students will be able to understand the compressibility behaviour of saturated/unsaturated soil.

Table-2

Slight (Low): 1 **Moderate: 2** **Substantial (High): 3** **No Correlation: "-"**

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE31E07.1	3	2	2	2	3	2
PCE31E07.2	3	2	2	2	3	2
PCE31E07.3	3	2	2	2	3	2
PCE31E07.4	3	2	2	2	3	2
PCE31E07.5	3	2	2	2	3	2
PCE31E07.6	3	2	2	2	3	2
Total	**18**	**12**	**12**	**12**	**18**	**12**
Average	**3**	**2**	**2**	**2**	**3**	**2**
Eq. Av Attainment	**3**	**2**	**2**	**2**	**3**	**2**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE31E07.1	3	3
PCE31E07.2	3	3
PCE31E07.3	3	3
PCE31E07.4	3	3
PCE31E07.5	3	3
PCE31E07.6	3	3
Total	**18**	**18**
Average	**3**	**3**
Eq. Avg Attainment	**3**	**3**

References:

1. Atkinson, J.H. and Bransby, P.L, The Mechanics of Soils: An introduction to critical soil mechanics, McGraw Hill, 1978.
2. Atkinson J. H, An introduction to the Mechanics of soils and Foundation, McGraw- Hill Co., 1993.
3. Das, B. M., Advanced Soil Mechanics, Taylor and Francis, 2nd Edition, 1997
4. Wood, D.M.,Soil Behavior and Critical State Soil Mechanics, Cambridge University Press, 1990.
5. Craig, R. F., Soil Mechanics, Van Nostrand Reinhold Co. Ltd., 1987.
6. Terzaghi, K., and Peck, R. B., Soil Mechanics in Engineering Practice, John Wiley & Sons, 1967.
7. Lambe, T. W. and Whitman, R. V., Soil Mechanics, John Wiley & Sons, 1979.

Railway Transportation System

(PCE31E08)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To understand the concept of railway geometric design and related approaches.
2. To illustrate the construction and maintenance process of railway track.
3. To explain the modernization of railways and rail transportation system planning.
4. To plan urban rail transit and its infrastructure.

Course Content:

Unit-1

Railway geometric design-- curves, cant Gradients and grade compensation, track diversion; turn out -- points and crossing and their design approaches.

Unit-2

Construction and maintenance of railway track, Control of train movements; Signals and interlocking.

Unit-3

Modernization of railways and future trends; Track standards and track rehabilitation.

Unit-4

Urban Rail Transit Planning – MRTS – LRTS, Metro Rail – Monorail – Network Design, Capacity and Traffic Fore casting - Case Studies.

Unit-5

Modern Transit Facilities - Railway Track – Transfer Station – Structures – Bridges – Tunnels – Planning and Design aspects.

Course Outcome:

1. Students will be able to understand the concept of railway geometric design and related approaches. (K2)
2. Students will be able to illustrate the construction and maintenance process of railway track. (K3)
3. Students will be able to explain the modernization of railways and rail transportation system planning. (K4)
4. Students will be able to plan urban rail transit and its infrastructure. (K6)

To establish the correlation between COs & POs

Table -1

No. of Course Outcome (CO)	Course Outcome
PCE31E08.1	Students will be able to recognize the concept of GIS including the knowledge of basic components and commercial use of GIS.
PCE31E08.2	Students will be able to interpret the process of data input and its interpolation technique.
PCE31E08.3	Students will be able to apply GIS in different types of fields for proper detection.
PCE31E08.4	Students will able to analyse different types of data and its presentation.

Table- 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE31E08.1	3	2	2	3	2	2
PCE31E08.2	3	2	2	3	3	2
PCE31E08.3	3	2	2	3	2	2
PCE31E08.4	3	2	2	3	2	2
Total	**12**	**8**	**8**	**12**	**9**	**8**
Average	**3**	**2**	**2**	**2**	**2.25**	**2**
Eq. Av Attainment	**3**	**2**	**2**	**2**	**2**	**2**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE31E08.1	3	4
PCE31E08.2	3	4
PCE31E08.3	3	4
PCE31E08.4	3	4
Total	**12**	**16**
Average	**3**	**4**
Eq. Avg Attainment	**3**	**4**

References:

Sl. No.	Name of Books	Author	Publisher
1	Urban Transit: Operations, Planning and Economics	Vukan R.Vuchie	John Wiley and Sons Inc.
2	Urban Transit Systems and Technology	Vukan R.Vuchie	John Wiley and Sons Inc.
3	Railway Track Engineering	J.S. Mundrey	Tata McGraw Hill Co. Ltd.

PRACTICAL/SESSIONAL

Pavement Engineering Laboratory-I

(PCE31P01)

Total Credits	02	L – T – P	0– 0 – 3

Course Objective:

1. To gain knowledge about the tests related to pavement materials.
2. To learn the method of performing different tests of pavement materials.
3. To apply different methods of performing tests in the field based on the appropriateness.

Course Content:

Unit-1

To determine the in situ density of natural or compacted soils using sand pouring cylinders.

Unit-2

To perform grain size analysis of soil.

Unit-3

To determine the consistency limits of soil sample.

Unit-4

To determine the relative density of given coarse grained material.

Unit-5

To determine the coefficient of permeability of a soil sample.

Unit-6

To conduct proctor compaction test of soil.

Unit-7

To find shear strength of a given soil specimen by vane shear test.

Unit-8

To find the shear of the soil by Undrained Triaxial Test.

Unit-9

To determine the settlements due to primary consolidation of soil by conducting one dimensional test.

Unit- 10

To determine the California bearing ratio by conducting a load penetration test in the laboratory.

Course Outcome:

1. Students will be able to explain the tests related to pavement materials. (K2)
2. Students will be able to apply different methods of performing tests in the field based on the appropriateness. (K3)
3. Students will be able to analyze the different tests of pavement materials. (K4)
4. Students will be able to recommend the appropriate test related to pavement materials based on the field condition. (K5)

To establish the correlation between COs & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE31P01.1	Students will be able to demonstrate the tests related to pavement materials.
PCE31P01.2	Students will be able to apply different methods of performing tests in the field based on the appropriateness.
PCE31P01.3	Students will be able to explain the different tests of pavement materials.
PCE31P01.4	Students will be able to recommend the appropriate test related to pavement materials based on the field condition.

Table 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE31P01.1	3	2	2	2	3	2
PCE31P01.2	3	2	2	2	2	2
PCE31P01.3	3	2	2	2	3	3
PCE31P01.4	3	2	2	2	2	2
Total	**12**	**8**	**8**	**8**	**10**	**9**
Average	**3**	**2**	**2**	**2**	**2.5**	**2.25**
Eq. Av Attainment	**3**	**2**	**2**	**2**	**3**	**2**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE31P01.1	2	3
PCE31P01.2	2	3
PCE31P01.3	2	3
PCE31P01.4	2	3
Total	**8**	**12**
Average	**2**	**3**
Eq. Avg Attainment	**2**	**3**

Traffic Engineering Laboratory

(PCE31P02)

Total Credits	02	L – T – P	0– 4 – 0

Course Objective:

1. To gain knowledge about the different field experiments related to Traffic Engineering.
2. To learn the method of performing different tests of Traffic Engineering.
3. To apply different methods of performing tests in the field based on the appropriateness.

Course Content:

Unit-1

To conduct the O-D survey related to traffic.

Unit-2

To conduct the traffic volume count & traffic density.

Unit-3

To conduct the spot speed study of traffic.

Unit-4

To conduct the traffic volume study in intersection.

Unit-5

To conduct the delay study in intersection.

Unit-6

To conduct the noise study of traffic.

Unit-7

To conduct the axle load survey.

Unit-8

To determine the PCU of traffic.

Course Outcome:

1. Students will be able to explain the tests related to Traffic Engineering. (K2)
2. Students will be able to apply different methods of performing tests in the field based on the appropriateness. (K3)
3. Students will be able to analyze the different tests of Traffic Engineering. (K4)
4. Students will be able to recommend the appropriate test related to Traffic Engineering based on the field condition. (K5)

To establish the correlation between COs & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE31P02.1	Students will be able to explain the tests related to Traffic Engineering.]
PCE31P02.2	Students will be able to apply different methods of performing tests in the field based on the appropriateness.
PCE31P02.3	Students will be able to analyze the different tests of Traffic Engineering.
PCE31P02.4	Students will be able to recommend the appropriate test related to Traffic Engineering based on the field condition.

Table 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE31P02.1	3	2	2	3	2	2
PCE31P02.2	3	2	2	3	2	2
PCE31P02.3	3	2	2	3	2	2
PCE31P02.4	3	2	2	3	2	2
Total	**12**	**8**	**8**	**12**	**8**	**8**
Average	**3**	**2**	**2**	**3**	**2**	**2**
Eq. Av Attainment	**3**	**2**	**2**	**3**	**2**	**2**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE31P02.1	3	3
PCE31P02.2	3	3
PCE31P02.3	3	3
PCE31P02.4	3	3
Total	**12**	**12**
Average	**3**	**3**
Eq. Avg Attainment	**3**	**3**

Seminar

(PCE31P03)

Total Credits	**01**	**L – T – P**	**0– 0 – 1**

Each Student shall prepare a Report and present a Seminar on topic related to the branch of specialization under the guidance of a Faculty member. The student shall submit copy of the paper to the Department. Grades will be awarded on the basis of contents of the paper and the presentation.

SECOND SEMESTER		No. of Classes/Week			Total Credits	Marks
Sl. No.	**Subject**	**Lecture**	**Tutorial**	**Practical**		
1	**Basic Core** PCE32B01:Analysis & Design of Pavements	03	01	00	4	100
2	**Elective Paper-III (Any One)** PCE32E01:Geometric Design of Transportation Facilities PCE32E02: Ecology & Environmental Impact Assessment PCE32E03: Geo-environmental Engineering	03	01	00	4	100
3	**Elective Paper-IV (Any One)** PCE32E04: Bridge Engineering PCE32E05: Pavement Evaluation, Rehabilitation and Maintenance PCE32E06: Urban Mass Transit Planning, Operations and Management	03	01	00	4	100
4	**Elective Paper-V (Any One)** PCE32E07: Ground Improvement Technique PCE32E08: Finite Element Method PCE32E09: Advanced Traffic Engineering	03	01	00	4	100
5	PCE32P01: Project Preliminaries	00	00	04	4	100
6	PCE32P02: Pavement Engineering Laboratory-II	00	00	04	2	100
7	PCE32P03: Computer Oriented Design Lab	00	00	04	2	100
8	PCE32P04: Comprehensive Viva-voce	00	00	00	1	100
	Total	**12**	**04**	**12**	**25**	**800**

Analysis & Design of Pavements

(PCE32B01)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. Identify and categorize the factors affecting design and performance of pavements.
2. To understand basic modelling concepts used to analyse flexible and rigid pavements.
3. To understand different design methods for flexible and rigid pavement design
4. Develop skills to perform functional and structural evaluation of pavement

Course Content:

Unit -1

Types of pavement – Factors affecting design of pavements – wheel loads –ESWL Concept- tyre pressure – contact pressure, Material characteristics – Environmental and other factors.

Unit-2

Stresses in flexible pavement – layered systems concept – one layer system – Boussinesq, Two layer system – Burmister Theory and problems on above.

Unit-3

Stresses in rigid pavements – relative stiffness of slab, modulus of sub-grade reaction – stresses due to warping, stresses due to loads, stresses due to friction.

Unit-4

Pavement design: IRC method of flexible pavement design.- AASHO Method of Flexible Pavement design. , Design methods for airfield pavements, problems of the above

Unit-5

IRC method of Rigid pavement design, AASHTO Method, PCA method of design – Importance of Joints in Rigid Pavements- Types of Joints – Use of Tie Bars and Dowell Bars. , Design methods for airfield pavements, problems of the above

Unit-6

Need for Highway Maintenance- Pavement Failures- Failures in Flexible Pavements-Types and Causes-Rigid Pavement Failures- Types and causes- Pavement Evaluation- Structural evaluation by Benkleman beam deflection method, Falling weight deflectometer, GPR method.

Course Outcome:

1. List and explain the various factors affecting design and performance of pavements
2. Calculate the stresses and deflection in flexible and rigid pavements
3. Design flexible and rigid pavements
4. Design flexible and rigid overlay.

To establish the correlation between COs & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE32B01.1	List and explain the various factors affecting design and performance of pavement
PCE32B01.2	Calculate the stresses and deflection in flexible and rigid pavements
PCE32B01.3	Design flexible and rigid pavements
PCE32B01.4	Design flexible and rigid overlay

Table- 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE32B01.1	3	3	3	3	2	3
PCE32B01.2	3	3	3	3	2	3
PCE32B01.3	3	3	3	3	2	3
PCE32B01.4	3	3	3	3	2	3
Total	**12**	**12**	**12**	**12**	**8**	**12**
Average	**3**	**3**	**3**	**3**	**2**	**3**
Eq. Av Attainment	**3**	**3**	**3**	**3**	**2**	**3**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE32B01.1	4	3
PCE32B01.2	4	3
PCE32B01.3	4	3
PCE32B01.4	4	3
Total	**16**	**12**
Average	**4**	**3**
Eq. Avg Attainment	**4**	**3**

Reference:

1. Pavement Analysis and Design, Yang H. Hung, Prentice-Hall

2. Principles of Pavement Design Yoder & Witczak Wiley Publication

3. IRC: 37 & 58 Codes for Flexible and Rigid Pavements Design.

ELECTIVE PAPER-III

Geometric Design of Transportation Facilities

(PCE32E01)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To study the different types of highways and the performance of users on those highways.
2. To evaluate the various safety measures of the highways and their design along with hill roads.
3. To understand the importance of intersection in road and their design.
4. To be familiar with the different types of ramp, other types of lanes and parking lots along with their design.

Course Content:

Unit-1

Highway functional classification; route layout and selection; design controls and criteria: vehicular characteristics, turning paths; driver performance; traffic characteristics; highway capacity.

Unit -2

Access control; safety; elements of design: sight distances, horizontal alignment, transition curves, super elevation and side friction; vertical alignment: grades, crest and sag curves; highway cross-sectional elements and their design; Hill road.

Unit -3

Intersections -- at-grade intersections, sight distance consideration and principles of design, channelization, speed change lanes; Roundabout, mini roundabouts, design of roundabouts.

Unit -4

Inter-changes, types of interchanges, entrance and exit ramps, ramp metering; Bicycle and pedestrian facility design; Parking layout and design; Terminal layout and design.

Course Outcome:

1. Students will be able to identify the different types of highways, characteristics of driver, traffic and other users on those highways (K1).
2. Students will be able to apply the design and construction of various safety measures in highways and hill roads (K3).
3. Students will be able to explain the design and construction of road intersection, roundabouts etc (K4).
4. Students will be able to evaluate the requirements of different types of entry and exit in highways, bicycle lane, parking lots etc and their design techniques (K5).

To establish the correlation between Cos & POs

No. of Course Outcome (CO)	Course Outcome
PCE32C01.1	Students will be able to identify the different types of highways, characteristics of driver, traffic and other users on those highways (K1).
PCE32C01.2	Students will be able to apply the design and construction of various safety measures in highways and hill roads (K3).
PCE32C01.3	Students will be able to explain the design and construction of road intersection, roundabouts etc (K4).
PCE32C01.4	Students will be able to evaluate the requirements of different types of entry and exit in highways, bicycle lane, parking lots etc and their design techniques (K5).

Table 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE32C01.1	3	3	2	3	2	3
PCE32C01.2	3	3	3	3	3	3
PCE32C01.3	3	3	2	3	2	2
PCE32C01.4	2	2	3	3	2	3
Total	**11**	**11**	**10**	**12**	**9**	**11**
Average	**2.75**	**2.75**	**2.5**	**3**	**2.25**	**2.75**
Eq. Av Attainment	**3**	**3**	**3**	**3**	**2**	**3**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE32C01.1	3	3
PCE32C01.2	3	3
PCE32C01.3	3	3
PCE32C01.4	3	3
Total	**12**	**12**
Average	**3**	**3**
Eq. Avg Attainment	**3**	**3**

Reference:

Sl. No.	Name of Books	Author	Publisher
1	Highway Engineering	Khanna & Justo	Nem Chand Bros
2	Highway Engineering	Rogers, Martin	Blackwell Publisher
3.	Principles of Transportation, and Highway Engineering	Rao, G.V,	Tata McGraw Hill
4.	Highway Transportation Engineering	Roger P. Roess,Person US Import & John C. Falcocchio	PHIPEs

Ecology & Environmental Impact Assessment

(PCE32E02**)**

Total Credits	04	L – T – P	3 – 1 – 0

Course Objectives:

1. To make the students able to understand structure and function of ecosystem in conservation of different kind of Environmental system.
2. To have adequate knowledge on principles, modeling and application of ecological engineering.
3. To have adequate knowledge on scope and contents, methodologies and techniques of Environmental Impact Assessment.
4. To have understanding of prediction and assessment of impacts on the surface water environment.
5. To have understanding of prediction and assessment of impacts on the air environment.
6. To have understanding of prediction and assessment of impacts on the land environment.
7. To understand the basics of risk characterisation and risk reduction.
8. To have sufficient knowledge of case studies related to Environmental Impact Assessment.

Course Content:

Unit 1

Ecology – Classification of Ecosystems, Structure and Function of Ecosystems, Energy Flow in Ecosystems, Ecological Niche and succession, Bio-geo-chemical cycles, Ecological Pyramids.

Unit 2

Ecosystems – Biotic and abiotic components, production and consumption, trophic levels, productivity and energy flow, food webs, cycling of elements.

Unit 3

Changes in ecosystems – Succession, long range changes, long range stability, the organization and dynamics of ecological communities, description and study of typical natural and artificial ecosystems.

Unit 4

Principles of ecological engineering – Principles, components and characteristics of Systems - Classification of systems - Structural and functional interactions of environmental systems - Environmental systems as energy systems - Mechanisms of steady-state maintenance in open and closed systems - Modelling and ecotechnology - Elements of modelling - Modelling procedure - Classification of ecological models - Applications of models in ecotechnology - Ecological economics.

Unit 5

Aquatic and Terrestrial Ecosystems – Diversity and dominance Indices, Ecosystem Models.

Unit 6

Climate change and biodiversity, Application of ecological engineering – Ecosanitation - Principles and operation of soil infiltration systems - Wetlands and ponds - Source separation systems - Aquacultural systems - Detritus based treatment for solid wastes - Applications of ecological engineering for marine systems.

Unit 7

Lake Ecosystem – trophic levels, nutrient loading, nutrient enrichment, Leibig's Law, control of eutrophication.

Unit 8

Environmental Impact Assessment – Definition, Objectives, Types – Rapid and Comprehensive EIA, EIS, FONSI, Step-by-step procedure for conducting EIA and Limitations of EIA, Prevention of Significant Deterioration (PSD) Programme.

Unit 9

Frame work of Impact Assessment – scope and contents of EIA, methodologies and techniques of EIA.

Unit 10

Prediction and Assessment of Impacts on the Surface Water Environment – Quality Impacts, Quantity Impacts, Water Quality Index, Mass Balances, Quantitative Modeling, Water Conservation - Case Study. Prediction and Assessment of Impacts on the Groundwater Environment: Hydrogeological Information, Vulnerability Mapping, Subsurface Transport and Fate.

Unit 11

Prediction and Assessment of Impacts on the Air Environment – Air Pollutants Emission, Ambient Air Quality and Standards, Emission Inventories, Meteorological Data, Mass Balances, Dispersion Models, Pollutant Emissions Minimization - Case Study.

Unit 12

Prediction and Assessment of Impacts on the Land Environment – Soil & Geological properties, Universal Soil Loss equation, mitigation measures.

Unit 13

Risk Assessment – Hazard Identification, Effect Assessment, Risk characterization, Risk Reduction.

Unit 14

Attributes, Standards and Value functions, public participation in EIA. Environmental Management Plan (EMP) and Disaster Management Plan (DMP).

Unit 15

EIA Case Studies – Thermal Power Plant, Mining, Fertilizer, Construction Projects, Airport, Water and Wastewater Treatment Plants.

References

1. Kormandy, (1996), "Concepts of Ecology", 4th Edition, Prentice Hall publication, New Jersey.
2. Odum, (1974), "Fundamentals of Ecology", 3rd Edition, W.B. Saunders & CO, NBF.
3. Krebs J., (2008), "Ecology – The Experimental Analysis of Distribution and Abundance", 6th Edition, Perason International.
4. Hall C.A.S., and Day J.W. (1977), "Ecosystem Modeling in Theory and Practice: An Introduction with Case Histories", John Willey.
5. Canter L., (1995), "Environmental Impact Assessment", 2nd Edition, McGraw Hill Higher Education.

6. Weathern, P., (1982), "Environmental Impact Assessment – Theory and Practice", Unwin Hyman, London.
7. Jain R.K., Urban L.V., Stacey G.S., (1981), "Environmental Impact Analysis – A New Dimension in Decision Making", 2nd Edition, Van Nostrand Reinhold Co.
8. Clark B.C., Bisett and Tomilson P, (1985), "Perspective on Environmental Impact Assessment", Allied Publishers.
9. Charles, H., (2011), "Environmental Impact Assessment", 1st Edition, CRC Press.
10. Rau and Wooten, (1981). "Environmental Impact Assessment Handbook", McGraw Hill.

Course Outcomes (CO):

1. Students will be able to understand structure and function of ecosystem in conservation of different kind of Environmental system.
2. Students will be able to understand principles, modeling and application of ecological engineering.
3. Students will have adequate knowledge of scope and contents, methodologies and techniques of Environmental Impact Assessment.
4. Students will have understanding of prediction and assessment of impacts on the surface water environment, air environment and land environment.
5. Students will have understanding of basics of risk characterisation and risk reduction.
6. Students will have sufficient knowledge of case studies related to Environmental Impact Assessment.

Table 1: To establish the correlation between COs & POs

No. of Curse Outcome (CO)	Course Outcome
PCE42C03.1	Students will be able to understand structure and function of ecosystem in conservation of different kind of Environmental system.
PCE42C03.2	Students will be able to understand principles, modeling and application of ecological engineering.
PCE42C03.3	Students will have adequate knowledge of scope and contents, methodologies and techniques of Environmental Impact Assessment.
PCE42C03.4	Students will have understanding of prediction and assessment of impacts on the surface water environment, air environment and land environment.
PCE42C03.5	Students will have understanding of basics of risk characterisation and risk reduction.
PCE42C03.6	Students will have sufficient knowledge of case studies related to Environmental Impact Assessment.

Table-2: Correlation between COs & POs

Slight (LOW): 1 Moderate (MEDIUM): 2 Substantial (HIGH): 3 and for NO CORELATION: '-'

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE42C01.1	3	2	3	2	3	3
PCE42C01.2	3	2	3	3	2	2
PCE42C01.3	3	2	3	3	2	2
PCE42C01.4	3	2	3	2	3	3
PCE42C01.5	3	2	3	3	3	2
PCE42C01.6	3	2	3	3	2	2
Total	**18**	**12**	**18**	**16**	**15**	**14**
Average	**3**	**2**	**3**	**2.67**	**2.5**	**2.33**
Equivalent Avg. Attainment	**3**	**2**	**3**	**3**	**3**	**2**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE42C03.1	3	3
PCE42C03.2	3	3
PCE42C03.3	3	3
PCE42C03.4	3	3
PCE42C03.5	3	3
PCE42C03.6	3	3
Total	18	18
Average	3	3
Equivalent Avg. Attainment	**3**	**3**

Geo-Environmental Engineering

(PCE32E03)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objectives:

1. To have sufficient knowledge on fundamentals of Geoenvironmental Engineering.
2. To have adequate knowledge on planning and design of MSW and Hazardous waste Landfills.
3. To have better understanding on planning and design of slurry ponds - ash ponds and tailing ponds.
4. To have better understanding on subsurface contamination.
5. To have understanding of geotechnical reuse of waste.

Course Content:

Unit 1

Concepts and principles of Geoenvironmental Engineering.

Unit 2

Geotechnical aspects of planning and design of MSW and Hazardous waste Landfills

Unit 3

Geotechnical aspects of planning and design of slurry ponds - ash ponds and tailing ponds.

Unit 4

Geotechnical aspects of detection & monitoring of subsurface contamination and control & remediation of contaminated sites.

Unit 5

Rehabilitation of waste dumps and geotechnical re-use of waste.

References:

1. Rowe R.K.,"Geotechnical and Geoenvironmental Engineering Handbook" Kluwer Academic Publications, London, 2000.
2. Reddi L.N. and Inyang, H. I.,"Geoenvironmental Engineering,Principles and Applications" Marcel Dekker Inc. New York, 2000.
3. Yong, R. N.,"Geoenvironmental Engineering, Contaminated Soils,Pollutant Fate, and Mitigation" CRC Press, New York, 2001.
4. Sharma H.D. and Reddy K.R.,"Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies" John Wiley & Sons, Inc., USA, 2004.
5. Fredlund D.G. and Rahardjo, H.,"Soil Mechanics for Unsaturated Soils" Wiley- Interscience, USA, 1993.
6. Mitchell, J.K.,"Fundamentals of Soil Behavior" Wiley, 2005.
7. Hillel D.,"Introduction to Environmental Soil Physics" Academic Press, New York, 2003.

Course Outcomes (CO):

1. Students will be able to understand fundamentals of Geoenvironmental Engineering.
2. Students will have knowledge on planning and design of MSW and Hazardous waste Landfills.
3. Students will have adequate knowledge on planning and design of slurry ponds - ash ponds and tailing ponds.
4. Students will have adequate knowledge on subsurface contamination.
5. Students will have understanding on reuse of geotechnical waste.

Table 1: To establish the correlation between COs & POs

No. of Curse Outcome (CO)	Course Outcome
PCE32E03.1	Students will be able to understand fundamentals of Geoenvironmental Engineering.
PCE32E03.2	Students will have knowledge on planning and design of MSW and Hazardous waste Landfills.
PCE32E03.3	Students will have adequate knowledge on planning and design of slurry ponds - ash ponds and tailing ponds.
PCE32E03.4	Students will have adequate knowledge on subsurface contamination.
PCE32E03.5	Students will have understanding on reuse of geotechnical waste.

ELECTIVE-IV

Bridge Engineering

(PCE32E04)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To learn the components of bridges, classification of bridges, importance of bridges and to understand the investigation for bridges, subsoil exploration, choice of bridge type.
2. To study the specification of road bridges, loads to be considered.
3. To familiarize students with various types of bridges and their design procedure.
4. To get exposure to evaluation of sub structures and foundations.
5. To understand the importance of bearings, expansion joints and lessons from bridge failures.

Course Content:

Unit-1

Introduction- Historical development of Bridge – Components of Bridges – Classification – Importance of Bridges – Investigation for Bridges – Selection of Bridge site – Economical span – Location of piers and abutments – Subsoil exploration – Scour depth – Traffic projection – Choice of bridge type.

Unit-2

Specification of road bridges – width of carriageway – loads to be considered - dead load – IRC standard live load – Impact effect.

Unit-3

General design considerations – Slab Bridge – Design of T-beam bridge – Box culvert- Overview on continuous bridge – balanced cantilever bridge- Arch Bridge – Box girder bridge decks.

Unit-4

Evaluation of sub structures – Pier and abutments caps – Design of pier – Abutments – Type of foundations.

Unit-5

Importance of Bearings – Bearings for slab bridges – Bearings for girder bridges – Elastomeric bearing – Joints – Expansion joints. Construction and Maintenance of bridges – Lessons from bridge failures.

Course Outcome:

1. To be familiar with the components of bridges, classification of bridges, importance of bridges and to understand the methods of investigation for bridges, subsoil exploration, choice of bridge type.
2. To understand the specification of road bridges, loads to be considered.
3. To be familiar with various types of bridges such as slab-bridge, T-beam bridge, continuous bridge, balanced cantilever bridge, arch bridge, box girder bridge.
4. To get exposed to evaluation of sub structures and foundations.
5. To be familiar with importance of bearings, expansion joints and lessons from bridge failures.

To establish the correlation between COs & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE32E04.1	Students will be able to learn components of bridges, classification of bridges, importance of bridges and understand the methods of investigation for bridges, subsoil exploration, choice of bridge type.
PCE32E04.2	Students will be able to understand the specification of road bridges, loads to be considered.
PCE32E04.3	Students will be familiar with various types of bridges such as slab-bridge, T-beam bridge, continuous bridge, balanced cantilever bridge, arch bridge- box girder bridge.
PCE32E04.4	Students will be exposed to evaluation of sub structures and foundations
PCE32E04.5	Students will be familiar with importance of bearings, expansion joints and lessons from bridge failures.

Table-2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE32E04.1	2	3	2	3	3	2
PCE32E04.2	2	1	1	2	3	3
PCE32E04.3	3	3	3	1	3	2
PCE32E04.4	3	3	3	2	3	2
PCE32E04.5	3	3	3	3	3	2
Total	**13**	**13**	**12**	**11**	**15**	**11**
Average	**3**	**3**	**3**	**2.2**	**3**	**2.2**
Eq. Av Attainment	**3**	**3**	**3**	**2**	**3**	**2**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE32E04.1	4	4
PCE32E04.2	4	4
PCE32E04.3	4	4
PCE32E04.4	4	4
PCE32E04.5	4	4
Total	**20**	**20**
Average	**4**	**4**
Eq. Avg Attainment	**4**	**4**

References:

Sl. No.	Name Of Book	Author	Publisher
1.	Bridge Engineering	Ponnuswamy, S.	Tata McGraw – Hill, New Delhi, 1997
2.	Essentials of Bridge Engineering	Victor, D. J.	Oxford and IBH Publishers Co., New Delhi, 1980.
3.	Bridge Superstructure	N. Rajagopalan	Narosa Publishing House, New Delhi, 2006
4.	Design of Bridge Structures	Jagadeesh. T. R. and Jayaram. M. A.	Prentice Hall of India Pvt. Ltd., 2004.
5	Concrete Bridge Practice	Raina. V. K.	Tata McGraw Hill Publishing Company, New Delhi, 1991.

Pavement Evaluation, Rehabilitation and Maintenance

(PCE32E05)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To understand the concept of pavement distress and its different types.
2. To study the techniques for functional and structural evaluation of pavements.
3. To evaluate different types of survey and rehabilitation techniques.
4. To design procedures of overlay for different types of pavements and their recycling.

Course Content:

Unit-1

Types of pavement distress; Techniques for functional and structural evaluation of pavements.

Unit-2

Network and project survey and evaluation; Pavement rehabilitation techniques.

Unit-3

Overlay design procedures for flexible & rigid pavements, recycling of flexible and rigid pavements.

Unit-4

Maintenance of paved and unpaved roads, Pavement management systems, Life cycle cost.

Course Outcome:

1. Students will be able to describe the concept of pavement distress and its different types. (K2)
2. Students will be able to illustrate the techniques for functional and structural evaluation of pavements. (K3)
3. Students will be able to evaluate different types of survey and rehabilitation techniques. (K5)
4. Students will be able to design procedures of overlay for different types of pavements and their recycling. (K6)

To establish the correlation between COs & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE32E05.1	Students will be able to describe the concept of pavement distress and its different types.
PCE32E05.2	Students will be able to illustrate the techniques for functional and structural evaluation of pavements.
PCE32E05.3	Students will be able to evaluate different types of survey and rehabilitation techniques.
PCE32E05.4	Students will be able to design procedures of overlay for different types of pavements and their recycling.

Table 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE32E05.1	3	1	1	2	2	2
PCE32E05.2	3	2	2	3	2	3
PCE32E05.3	3	3	3	2	2	2
PCE32E05.4	3	3	3	2	2	2
Total	**12**	**9**	**9**	**9**	**8**	**9**
Average	**3**	**2.25**	**2.25**	**2.25**	**2**	**2.25**
Eq. Av Attainment	**3**	**2**	**2**	**2**	**2**	**2**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE32E05.1	3	4
PCE32E05.2	3	4
PCE32E05.3	3	4
PCE32E05.4	3	4
Total	**12**	**16**
Average	**3**	**4**
Eq. Avg Attainment	**3**	**4**

References:

Sl. No.	Name of Books	Author	Publisher
1	Pavement Analysis and Design	Yang H. Hung	Prentice-Hall
2	Design and Performance of Road Pavements	David Croney	McGraw Hill
3	Guide for Design of Pavement	AASHTO	AASHTO

Urban Mass Transit Planning, Operations and Management

(PCE32E06)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To understand the concept of public transportation in urban area and the technology of public transit.
2. To illustrate estimation of demand in transit planning and its functional design.
3. To evaluate performance of transit systems and its operational management.
4. To create demand modelling and development of transit cost alongwith data and analysis technique.

Course Content:

Unit-1

Modes of public transportation and their roles to meet urban travel needs; comparison of transit modes and selection of technology and transit service.

Unit-2

Estimating demand in transit planning studies and functional design of transit routes; routing and scheduling of transit services; terminal design.

Unit-3

Management and operation of transit systems; performance evaluation of systems; transit and urban development.

Unit-4

Challenges, Demand Modeling, Development of Generalized Cost, RP & SP Data and Analysis Techniques, Case Studies.

Course Outcome:

1. Students will be able to explain the concept of public transportation in urban area and the technology of public transit. (K2)
2. Students will be able to illustrate estimation of demand in transit planning and its functional design. (K3)
3. Students will be able to evaluate performance of transit systems and its operational management. (K5)
4. Students will be able to create demand modelling and development of transit cost alongwith data and analysis technique. (K6)

To establish the correlation between COs & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE32E06.1	Students will be able to explain the concept of public transportation in urban area and the technology of public transit.
PCE32E06.2	Students will be able to illustrate estimation of demand in transit planning and its functional design.
PCE32E06.3	Students will be able to evaluate performance of transit systems and its operational management.
PCE32E06.4	Students will be able to create demand modelling and development of transit cost alongwith data and analysis technique.

Table 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE32E06.1	3	3	3	2	3	3
PCE32E06.2	3	3	2	2	3	2
PCE32E06.3	3	2	3	2	3	2
PCE32E06.4	3	3	2	2	3	3
Total	**12**	**11**	**10**	**8**	**12**	**10**
Average	**3**	**2.75**	**2.5**	**2**	**3**	**2.5**
Eq. Av Attainment	**3**	**3**	**3**	**2**	**3**	**3**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE32E06.1	3	4
PCE32E06.2	3	4
PCE32E06.3	3	4
PCE32E06.4	3	4
Total	**12**	**16**
Average	**3**	**4**
Eq. Avg Attainment	**3**	**4**

References:

Sl. No.	Name of Books	Author	Publisher
1	Urban Mass Transportation Planning	Alan Black	Mcgraw-Hill College

ELECTIVE-V

Ground Improvement Technique

(PCE32E07)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To understand the necessity of ground improvement techniques
2. To understand the details of mechanical stabilization
3. To understand the ground improvement by drainage
4. To understand the applications of admixtures for ground improvement
5. To understand the applications of grouting techniques
6. To understand the in situ soil treatment methods
7. To understand the case studies of ground improvement projects.

Course Content:

Unit-1
Introduction: Need for Ground Improvement, Different types of problematic soils, Emerging trends in ground Improvement.

Unit-2
Mechanical stabilization: Shallow and deep compaction requirements, Principles and methods of soil compaction, Shallow compaction and methods. Properties of compacted soil and compaction control, Deepcompaction and Vibratory methods Dynamic compaction.

Unit-3
Hydraulic modification: Ground Improvement by drainage, Dewatering methods. Design of dewatering systems, Preloading, Vertical drains, vacuum consolidation, Electro-kinetic dewatering, design andconstruction methods.

Unit-4
Modification by admixtures: Cement stabilization and cement columns, Lime stabilization and lime columns. Stabilization using bitumen and emulsions, Stabilization using industrial wastes Construction techniques andapplications.

Unit 5
Grouting: Permeation grouting, compaction grouting, jet grouting, different varieties of grout materials,grouting under difficult conditions.

Unit-6
In situ soil treatment methods: Soil nailing, rock anchoring, micro-piles, design methods, construction techniques.

Unit-7
Case studies: Case studies of ground improvement projects.

Course Outcome:

1. Students will be able to understand the necessity of ground improvement techniques
2. Students will be able to understand the details of mechanical stabilization
3. Students will be able to understand the ground improvement by drainage
4. Students will be able to understand the applications of admixtures for ground improvement
5. Students will be able to understand the applications of grouting techniques
6. Students will be able to understand the in situ soil treatment methods
7. Students will be able to understand the case studies of ground improvement projects.

To establish the correlation between COs & POs
Table-1

No. of Course Outcome (CO)	Course Outcome
PCE32E07.1	Students will be able to understand the necessity of ground improvement techniques
PCE32E07.2	Students will be able to understand the details of mechanical stabilization
PCE32E07.3	Students will be able to understand the ground improvement by drainage
PCE32E07.4	Students will be able to understand the applications of admixtures for ground improvement
PCE32E07.5	Students will be able to understand the applications of grouting techniques
PCE32E07.6	Students will be able to understand the in situ soil treatment methods
PCE32E07.7	Students will be able to understand the case studies of ground improvement projects

Table-2

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE32E07.1	3	2	2	3	2	3
PCE32E07.2	3	2	2	3	2	3
PCE32E07.3	3	2	2	3	2	3
PCE32E07.4	3	2	2	3	2	3
PCE32E07.5	3	2	2	3	2	3
PCE32E07.6	3	2	2	3	2	3
PCE32E07.7	3	2	2	3	2	3
Total	**21**	**14**	**14**	**21**	**14**	**21**
Average	**3**	**2**	**2**	**3**	**2**	**3**
Eq. Av Attainment	**3**	**2**	**2**	**3**	**2**	**3**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE32E07.1	4	3
PCE32E07.2	4	3
PCE32E07.3	4	3
PCE32E07.4	4	3
PCE32E07.5	4	3
PCE32E07.6	4	3
PCE32E07.7	4	3
Total	**28**	**21**
Average	**4**	**3**
Eq. Avg Attainment	**4**	**3**

References:

Sl. No.	Name of the Books	Authors	Publishers
1.	Ground Improvement Techniques	P. Purushothama Raj	Laxmi Publications (P) Ltd.
2.	Engineering Principles of Ground Modification	Manfired R. Hausmann	McGraw-Hill Pub, Co.
3.	Designing with geosynthetics	R. M. Koerner	Prentice Hall Inc.
4.	Guidelines on ground improvement for structure and facilities	U. S. Army Corps of Engineers	U. S. Army Corps of Engineers, Washington DC
5.	Ground Control and Improvement	Petros P. Xanthakos, Lee W. Abramson and Donald A. Bruce	John Wiley, New York

Additional Readings:

Journal and Conference papers in the area of Ground Improvement, Ground Engineering, Geotextiles and geomembranes, Geosynthetics, etc.

Finite Element Method
(PCE32E08)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. Understand the mathematical and physical principles underlying the Finite Element Method (FEM) focussed on stress analysis of common geotechnical engineering problems.
2. Demonstrate the ability to formulate and implement to solve geotechnical engineering problems using Finite Element Analysis.
3. Be able to evaluate accuracy of the Finite Element solutions using a range of techniques.
4. Be able to create his/her own FEM computer programs, for simple problems.
5. Understand the importance of analysis, using FEM, in the broader context of engineering practice.

Course Content:

Unit- 1

Introduction: Boundary Value Problem - Approximate Solution - Variational and Weighted Residual Methods - Ritz and Galerkin Formulations - Concepts of Piecewise Approximation and Finite Elements - Displacement and Shape Functions - Weak Formulation - Minimum Potential Energy - Generation of Stiffness Matrix and Load Vector.

Unit- 2

Stress Analysis: Two Dimensional problems - Plane Stress, Plain Strain and Axisymmetric Problems - Triangular and Quadrilateral Elements - Natural Coordinates - Isoparametric Formulation - Numerical Integration - Plate Bending and Shell Elements - Brick Elements - Elements for Fracture Analysis.

Unit- 3

Meshing and Solution Problems: Higher Order Elements - p and h Methods of refinement - IIL conditioned Elements - Discretization Errors -Auto and Adaptive Mesh Generation Techniques - Error Evaluation.

Unit- 4

Nonlinear and Vibration Problems: Material and Geometric Nonlinearity - Methods of Treatment - Consistent System Matrices – Dynamic Condensation - Eigen Value Extraction.

Unit- 5

Thermal Analysis: Thermal analysis problems.

Course Outcome:

At the end of the course, a student will be able to

1. Analyze linear 1D problem such as bars, beams, 2D problems using CST element, 4 node quadrilateral element, axi-symmetric problems with triangular elements, 3 and 4 node plate elements.
2. Write shape functions for 8 node quadrilateral, 6 node triangular (LST) elements, 8 node brick element, shell element, and apply numerical integration to solve; 1D and 2D; stiffness integrations.

3. Understand p and h Methods of refinement, discretization Errors and auto and adaptive mesh generation techniques.
4. Apply suitable boundary conditions to a global equation for various geotechnical engineering problems and solve them to determine displacements, stresses and strains.
5. Understand the finite element method to solve problems with material and geometric nonlinearity and vibration problems.
6. Critically assess a finite element analysis for correctness.

To establish the correlation between COs & POs
Table-1

No. of course outcome (CO)	Course Outcome
PCE32E08.1	Student will be able to analyze linear 1D problem such as bars, beams, 2D problems using CST element, 4 node quadrilateral element, axi-symmetric problems with triangular elements, 3 and 4 node plate elements.
PCE32E08.2	Student will be able to write shape functions for 8 node quadrilateral, 6 node triangular (LST) elements, 8 node brick element, shell element, and apply numerical integration to solve; 1D and 2D; stiffness integrations.
PCE32E08.3	Student will be able to understand p and h Methods of refinement, discretization Errors and auto and adaptive mesh generation techniques.
PCE32E08.4	Student will be able to apply suitable boundary conditions to a global equation for various geotechnical engineering problems and solve them to determine displacements, stresses and strains.
PCE32E08.5	Student will be able to understand the finite element method to solve problems with material and geometric nonlinearity and vibration problems.
PCE32E08.6	Student will be able to critically assess a finite element analysis for correctness.

Table-2

Slight (Low): 1 **Moderate: 2** **Substantial (High): 3** **No Correlation: "-"**

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE32E08.1	3	3	2	3	2	3
PCE32E08.2	3	3	2	3	2	3
PCE32E08.3	3	3	2	3	2	3
PCE32E08.4	3	3	2	3	2	3
PCE32E08.5	3	3	2	3	2	3
PCE32E08.6	3	3	2	3	2	3
Total	**18**	**18**	**12**	**18**	**12**	**18**
Average	**3**	**3**	**2**	**3**	**2**	**3**
Equivalent Avg. Attainment	**3**	**3**	**2**	**3**	**2**	**3**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE32E08.1	4	2
PCE32E08.2	4	2
PCE32E08.3	4	2
PCE32E08.4	4	2
PCE32E08.5	4	2
PCE32E08.6	4	2
Total	**24**	**12**
Average	**4**	**2**
Eq. Avg Attainment	**4**	**2**

References:

Sl. No.	Name of the Book	Author	Publisher
1	Finite Element Method	Zeinkiewicz, O. C.	Tata Mcgraw Hill, 1988
2	The Finite Element Method- Vol. I	Zeinkiewicz & Taylor	Mcgraw-Hill International Editions
3	The Finite Element Method- Vol. II	Zeinkiewicz & Taylor	Mcgraw-Hill International Editions
4	The Finite Element Method- Vol. III	Zeinkiewicz & Taylor	Mcgraw-Hill International Editions
5	Vibrations, Dynamics and Structural System	Mukhopadhyay, M.	Oxford and IBH
6	An Introduction to the Finite Element Method	Reddy, J. N.	Mcgraw-Hill International Editions
7	The Finite Element Analysis	Seshu, P.	PHI
8	Finite Element Procedures	Bathe, K. J.	Prentice Hall, 1996
9	A First Course in Finite Elements	Fish, J. and Belytschko, T.	John Willey & Sons, 2007
10	Concepts and Applications of Finite Element Analysis	Cook, R. D.	John Willey & Sons
11	Finite Element Analysis- Theory and Programming	Krishnamurthy, C. S.	Tata Mcgraw Hill
12	Introduction to Finite Element Vibration Analysis	Petyt, M.	Cambridge University Press

Advanced Traffic Engineering

(PCE32E09)

Total Credits	04	L – T – P	3 – 1 – 0

Course Objective:

1. To understand the concept of Traffic flow
2. To know the function of different intersections
3. To analyse the various aspect of road safety
4. To evaluate the traffic problem in cities including air pollution, noise pollution etc.

Course Content:

Unit-1

Traffic flow- Relationship between the variables, fundamental diagram of traffic flow Microscopic and macroscopic flow characteristics, Different models
Light hill and Witham's theory - Approach to signalized intersection, Bottleneck-, Green bergs extension law of continuity: Shock Wave Analysis;
Car following theories- Principles, Derivation of equation: Queuing Analysis;
Level of service – Concept in HCM manual, factors affecting capacity & level of service. Estimation of traffic for road construction.

Unit-2

Speed Change Lanes- Acceleration, Deceleration lane and Design
Intersection – At grade, Grade separated intersection, Channelized & Non- Channelized intersection; Rotary intersection – advantages, disadvantages & design; Signal- signal phasing, dilemma zone.

Unit -3

Road safety analysis – spot map, collision & condition diagram, causes and prevention of accidents, Types of crashes, Functional design implication in safety; Conflict- diverging, merging, crossing; Road safety Audit
Regulation of Traffic – Need for traffic regulation - traffic laws and regulation of speed.

Unit -4

Nature of traffic problems in cities – difficulties in urban traffic conditions, measures to meet the problem, promotion of public transport, pedestrianisation; Mode choice.
Environmental & Energy consideration in transportation – Air pollution, noise pollution, Fuel crisis, Factors affecting fuel consumption of motor vehicles; Vehicle Operating Costs – components of VOC, factors affecting VOC.

Course Outcome:

1. Students will be able to study the concept of Traffic flow including Level of service (K2)
2. Students will be able to acquire a idea regarding different intersections & their function including speed change lane (K2)
3. Students will be able to analyse accident study using the knowledge of spot map, collision & condition diagram etc. (K4)
4. Students can evaluate the traffic problems in cities & can take appropriate measures for smooth traffic operation (K5)

To establish the correlation between COs & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE32E09.1	Students will be able to study the concept of Traffic flow including Level of service
PCE32E09.2	Students will be able to acquire a idea regarding different intersections & their function including speed change lane.
PCE32E09.3	Students will be able to analyse accident study using the knowledge of spot map, collision & condition diagram etc.
PCE32E09.4	Students can evaluate the traffic problems in cities & can take appropriate measures for smooth traffic operation.

Table 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE32E09.1	3	3	3	3	2	2
PCE32E09.2	3	3	3	3	2	2
PCE32E09.3	3	3	3	3	2	2
PCE32E09.4	3	3	3	3	2	2
Total	**12**	**12**	**12**	**12**	**8**	**8**
Average	**3**	**3**	**3**	**3**	**2**	**2**
Eq. Av Attainment	**3**	**3**	**3**	**3**	**2**	**2**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE32E09.1	3	4
PCE32E09.2	3	4
PCE32E09.3	3	4
PCE32E09.4	3	4
Total	**12**	**16**
Average	**3**	**4**
Eq. Avg Attainment	**3**	**4**

References:

Sl No.	Name of Books	Author	Publisher
1	Introduction to traffic Engg: A manual for data collection and analysis	Thomas Currin	Brroks
2	Traffic Engineering and Transport Planning	L.R . Kadiyali	Khanna Publisher
3.	Traffic Engineering	Roger P Roess, Elena S Prassas	Prentice Hall
4.	Traffic Engineering Design Principle &Practice	Mike Siinn, Poter Guest, Paul Matthews	Elsevier

PRACTICAL/SESSIONAL

Project Preliminaries

(PCE32P01)

Total Credits	**04**	**L – T – P**	**0 – 0 – 4**

Each student will be given a Thesis/Project problem at the beginning of Second Semester. They will work on the literature survey, scope of work, equipment development etc. and submit a report/dissertation. The main Thesis/Project work will, however, be done in Third and Fourth Semester.

Pavement Engineering Laboratory-II
(PCE32P02)

Total Credits	02	L – T – P	0 – 0 – 4

Course Objective:

1. To gain knowledge about the tests related to pavement materials.
2. To learn the method of performing different tests of pavement materials.
3. To apply different methods of performing tests in the field based on the appropriateness.

Course Content:

Unit-1

To determine the impact value of coarse aggregate.

Unit-2

To determine the Los Angeles Abrasion test of coarse aggregate.

Unit-3

To determine the shape test of coarse aggregate.

Unit-4

To determine the CBR test of coarse aggregate.

Unit-5

To determine the rutting behavior of pavement materials.

Unit-6

To determine the percentage of binder content from asphalt mix.

Unit-7

To determine the Marshall stability test of asphalt mix.

Unit-8

To determine the skid resistance of road surface.

Unit-9

To determine the viscosity of bitumen.

Unit-10

To determine the permeability of concrete.

Unit-11

To conduct the RTFO test on Asphalt.

Unit-12

To determine the PCI for pavement surface.

Course Outcome:

1. Students will be able to explain the tests related to pavement materials. (K2)
2. Students will be able to apply different methods of performing tests in the field based on the appropriateness. (K3)
3. Students will be able to analyze the different tests of pavement materials. (K4)
4. Students will be able to recommend the appropriate test related to pavement materials based on the field condition. (K5)

To establish the correlation between COs & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE32P02.1	Students will be able to demonstrate the tests related to pavement materials.
PCE32P02.2	Students will be able to apply different methods of performing tests in the field based on the appropriateness.
PCE32P02.3	Students will be able to explain the different tests of pavement materials.
PCE32P02.4	Students will be able to recommend the appropriate test related to pavement materials based on the field condition.

Table 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE32P02.1	3	2	2	3	2	2
PCE32P02.2	3	2	2	3	2	2
PCE32P02.3	3	2	2	3	2	2
PCE32P02.4	3	2	2	3	2	2
Total	**12**	**8**	**8**	**12**	**8**	**8**
Average	**3**	**2**	**2**	**3**	**2**	**2**
Eq. Av Attainment	**3**	**2**	**2**	**3**	**2**	**2**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE32P02.1	2	3
PCE32P02.2	2	3
PCE32P02.3	2	3
PCE32P02.4	2	3
Total	**8**	**12**
Average	**2**	**3**
Eq. Avg Attainment	**2**	**3**

Computer Oriented Design Lab

(PCE32P03)

Total Credits	02	L – T – P	0 – 0 – 4

Course Objective:

1. To gain knowledge about the different softwares related to Transportation Engineering.
2. To learn the method of performing different softwares of Transportation Engineering.
3. To analyse collected data using appropriate softwares.

Course Content:

Unit-1
To learn Q-GIS software.
Unit-2
To learn Arc-GIS software.
Unit-3
To learn KENPAVE software.
Unit-4
To learn KENSLAB software.
Unit-5
To learn Abacus software.
Unit-6
To learn Biogeme software.

Course Outcome:

1. Students will be able to explain the operation of sofwares. (K2)
2. Students will be able to apply the softwares based on the application. (K3)
3. Students will be able to analyse the data using different softwares. (K4)
4. Students will be able to design any model using appropriate software. (K6)

To establish the correlation between COs & POs

Table-1

No. of Course Outcome (CO)	Course Outcome
PCE32P03.1	Students will be able to explain the operation of sofwares.
PCE32P03.2	Students will be able to apply the softwares based on the application.
PCE32P03.3	Students will be able to analyse the data using different softwares.
PCE32P03.4	Students will be able to design any model using appropriate software.

Table- 2

Slight (Low): 1 Moderate: 2 Substantial (High): 3 No Correlation: "-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
PCE32P03.1	3	2	2	3	2	2
PCE32P03.2	3	2	2	3	2	2
PCE32P03.3	3	2	2	3	2	2
PCE32P03.4	3	2	2	3	2	2
Total	**12**	**8**	**8**	**12**	**8**	**8**
Average	**3**	**2**	**2**	**2**	**2**	**2**
Eq. Av Attainment	**3**	**2**	**2**	**2**	**2**	**2**

Table 3: To establish the correlation between COs & PSOs

CO	PSO1	PSO2
PCE32P03.1	2	2
PCE32P03.2	2	2
PCE32P03.3	2	2
PCE32P03.4	2	2
Total	**8**	**8**
Average	**2**	**2**
Eq. Avg Attainment	**2**	**2**

Comprehensive Viva-Voce

(PCE32P04)

Viva-voce will be conducted for all the students at the end of the Second Semester in the department by the board of examiners constituted by the Transportation Engineering Section of Civil Engineering Department.

THIRD SEMESTER

Project & Thesis
(PCE33P01**)**

Each student will devote full time in the Third Semester on a Thesis/Project on an assigned research problem of Design/Development work under the supervision of a Faculty Member. They will present a part of the Thesis/Project Report at the end of the Third Semester which will be evaluated by a Board of Examiners consisting of the Supervisor and External Examiner. The evaluation of the above said Thesis will be followed by a viva-voce in front of faculty members and other post-graduate students.

THIRD SEMESTER			**No. of Classes/Week**			**Total Credits**	**Marks**
Sl. No.	**Subject Code**	**Name of the Subject**	**Lecture**	**Tutorial**	**Practical**		
1.	PCE33P01	Project & Thesis	00	00	Full	10	100
Total			**00**	**00**	**Full**	**10**	**100**

FOURTH SEMESTER

Project & Thesis

(PCE34P01)

Each student will devote full time in the Fourth Semester on a Thesis/Project on an assigned research problem of Design/Development work under the supervision of a Faculty Member. They will present a Final Thesis/Project Report at the end of the Fourth Semester which will be evaluated by a Board of Examiners consisting of the Supervisor and External Examiner. The evaluation of the above said Thesis will be followed by a viva-voce in front of faculty members and other post-graduate students.

FOURTH SEMESTER		**No. of Classes/Week**			**Total Credits**	**Marks**
Sl. No.	**Subject**	**Lecture**	**Tutorial**	**Practical**		
1	PCE34P01: Project & Thesis	00	00	Full	20	300
Total		**00**	**00**	**Full**	**20**	**300**