PO Statements:

PO-1. An ability to independently carry out research/investigation and development work to solve practical problems.

PO-2. An ability to write and present a substantial technical report/document.

PO-3. 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.

PO-4. Graduates of the program will develop the confidence to solve state-of-the-art problems in key areas of transportation engineering.

PO-5. Graduate will have the ability to work independently/ in a team with high ethical values towards social, environmental and economic issues.

Semester- I

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Code</th>
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**Total credits 8**

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### Elective- III

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### Elective- IV

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</table>

Text/References Books:

Course Outcomes: At the end of the course, students will be able to:

CO- 1 understand the concept of urban transportation system and their characteristics
CO- 2 understand and analyse the process of urban travel demand forecasting.
CO- 3 understand the relationship between transportation and land use.


Text/References Books:
Course Outcomes: At the end of the course, students will be able to:

CO-1 apply the concept of different road materials and its evaluation.

CO-2 understand and analyse the materials characterisation and their importance.

CO-3 impart knowledge of materials design and its quality aspects.

<table>
<thead>
<tr>
<th>CODE</th>
<th>Traffic Engineering</th>
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</table>

Vehicle Characteristics, Human Factors and Driver behaviour, Traffic control mechanism. Traffic studies- volume, speed and delay studies, elements of traffic flow theory. Characteristics of uninterrupted traffic, Capacity and LOS of Uninterrupted facilities, Characteristics of interrupted traffic, Traffic characteristics at Un-signalised intersections, Design of Signalized intersections, Capacity and LOS of Signalized intersections, Signal control and signal coordination.

Text/References Books:


Course Outcomes: At the end of the course, students will be able to:

CO-1 study fundamental characteristics of traffic stream and Drivers’ behaviour.

CO-2 understand different types of traffic control systems.
CO- 3 design traffic signal system at intersections.

CO- 4 estimate capacity and Level of Service for uninterrupted and interrupted flow facilities.

<table>
<thead>
<tr>
<th>CODE</th>
<th>Transportation Engineering Laboratory</th>
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</table>

Tests on bitumen, emulsion, cutback, soil and aggregates, aggregate blending, viscosity of binders. Viscoelastic properties of bituminous mixtures and bituminous mix design. Speed, headway and travel time studies on highways. Parking surveys, Traffic data collection and analysis.

**Text/References Books:**

1. MOST, Specifications for Road and Bridge Work (4th Revision), Ministry of Road Transport and Highways, 2001.

**Course Outcomes:** At the end of the course, students will be able to:

CO- 1 understand and perform the various tests on road material.

CO- 2 understand and analyse the mix design aspects.

CO- 3 study macroscopic and microscopic parameters of traffic.

**ELECTIVE-I**

<table>
<thead>
<tr>
<th>CODE</th>
<th>Hill Roads</th>
<th>L</th>
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</table>

Introduction to hill road, classification of terrains, features and planning of hill roads, development of hill roads in India. Alignment of hill roads, Geometrics of hill roads pavement formation, camber, sight distance, horizontal curves, vertical curves, hair pin bends. Construction of hill roads-formation works, rock cutting, retaining walls. Drainage systems on hill roads-components drainage system, road-side drains, cross drainage structures, sub-surface drainage. Maintenance of hill roads. Landslide-type of landslides, factors causing landslides, remedial measures of hill roads.

**Text/References Books:**

**Course Outcomes:** At the end of the course, students will be able to:

CO- 1 understand various features of Hill roads

CO- 2 learn the alignment and geometric design of Hill roads

CO- 3 study the Hill road drainage system

CO- 4 learn the maintenance of Hill roads

<table>
<thead>
<tr>
<th>CODE</th>
<th>Advanced Highway Materials</th>
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</table>


**Text/References Books:**

2. RRL, DSIR, Soil Mechanics for Road Engineers, HMSO, London, 1995
Course Outcomes: At the end of the course, students will be able to:

CO- 1 Understand the behaviour and characteristics materials used for different types of pavement.
CO- 2 Understand the utilization of waste and recycled materials in pavement construction.
CO- 3 Application of new pavement materials.
CO- 4 Understand the principles of mix design.

<table>
<thead>
<tr>
<th>CODE</th>
<th>Advanced Concrete Technology</th>
<th>L</th>
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</table>

Concrete science, standards and specifications. Chemical admixtures, mineral admixtures, polymer concrete, high volume fly ash concrete, high strength concrete, self-compacting concrete, reactive powder concrete, mass concrete, roller compacted concrete, oil well concrete. Durability and fire hazards in concrete, use of waste materials in concrete, NDT.

Text/References Books:

2. A.M. Neville, Properties of Concrete, ELBS Ed.

Course Outcomes: At the end of the course, students will be able to:

CO- 1 understanding of advanced concrete terminology.
CO- 2 understanding of the mixed design of concrete, high strength of concrete requirements for advanced concrete.
CO- 3 understanding to use plasticizers, effect of water cement ratio and super plasticizers used in the construction works.

ELECTIVE –II

<table>
<thead>
<tr>
<th>CODE</th>
<th>Geotechnical Earthquake Engineering</th>
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</table>

Introduction, Seismic risks and seismic hazards, cause and strength of earthquake, social and economical consequences, theory of dynamics and seismic response, the nature and attenuation of ground motion. Determination of site characteristics, local geology and soil condition, site
investigation and soil tests. Determination of design earthquake response spectra and accelerograms as design earthquake, criteria for earthquake resistant design. Site response to earthquake, liquefaction of saturated cohesionless soils, seismic response of soil structure system, shallow foundation, pile foundation, foundation in liquefiable ground. A seismic design of earth retaining structures.

Text/References Books:

Course Outcomes: At the end of the course, students will be able to:
CO-1 Solve problems relating to origin of earths and response of structures to earthquake vibrations.
CO-2 Solve problems relating to hazard analysis.
CO-3 Assess properties of soil effected by seismic wave propagation.
CO-4 Solve problems relating to the effect of ground shaking on stability of slopes.
CO-5 Apply earthquake mitigation theories on stability of structures.

<table>
<thead>
<tr>
<th>CODE</th>
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Introduction, Economic considerations, Consolidation by preloading and sand drains; strengthening by granular columns, Stone columns; lime columns; Compaction by vibrofloatation, blasting and dynamic consolidation; Improvement of deep strata of fine soils by vacuum dewatering, electroosmosis, ground freezing and thermal stabilization; Grouting techniques and principles. Reinforced earth and applications of geosynthetics; retaining walls, slopes, roads, erosion. Ground anchors and soil nailing; Problems and case histories.

Text/References Books:
Course Outcomes: At the end of the course, students will be able to:

CO- 1 learn the various methods of Ground Improvement Techniques.

CO- 2 understand the changes in behaviour of soil due to application of various ground improvement techniques.

CO- 3 apply the ground improvement methods in solving the problems associated with poor soils.

<table>
<thead>
<tr>
<th>CODE</th>
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Introduction about Rural Roads and Planning and Alignment: Importance of Rural roads, Classification of rural roads, Terrain classification, Socio-economic impact of rural roads. Data base for master plan, Concept of network planning, Rural Roads plan, Road alignment, Governing factors for route selection, Factors controlling alignment, Special considerations while aligning hill roads, Surveys, Detailed project report, Environmental issues.

Geometric Design and Road Materials: Introduction, Design speed, Basic principles of geometric design, Elements, Horizontal and vertical alignment, Alignment compatibility, Lateral and vertical clearances. General, Soil and material surveys, Soil as road construction material, Aggregates for pavement courses, Materials for bituminous construction, Materials for semi-rigid and rigid pavement, Materials for special pavements Climatic suitability of concrete materials.


Text/References Books:

2. Guidelines for the design of flexible pavements for low volume rural roads, IRC: SP: 72-2007
Course Outcomes: At the end of the course, students will be able to:

CO- 1 obtain a basic knowledge of rural road network and it influences on socio-economic condition of rural area.
CO- 2 learn basic principles of geometric design and the material used for rural road.
CO- 3 understanding the planning, alignment and design consideration for rural roads.
CO- 4 learning construction, quality control, and maintenance measures for rural roads.

Semester- II

<table>
<thead>
<tr>
<th>CODE</th>
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Philosophy of design of flexible and rigid pavements, analysis of pavements using different analytical methods, selection of pavement design input parameters - traffic loading and volume, material characterization, drainage, failure criteria, reliability, design of flexible and rigid pavements using different methods, comparison of different pavement design approaches, design of overlays and drainage system.

Text/References Books:


Course Outcomes: At the end of the course, students will be able to:

CO- 1 understand basic concepts of pavement structures and their structural behaviors.
CO- 2 learn different techniques for analysis of pavement structures.
CO- 3 impart knowledge of pavement design considerations and their performance evaluation.
CO- 4 apply probabilistic evaluation of pavement performance.

<table>
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Text/References Books:


Course Outcomes: At the end of the course, students will be able to:

CO- 1 understand the various urban transit modes and their characteristics in the realm of urban transportation system.
CO- 2 understand and estimate the capacity and quality of mass transit system.
CO- 3 understand the concept of route determination and scheduling.
CO- 4 understand the specific mode of mass transit systems through case studies.

<table>
<thead>
<tr>
<th>CODE</th>
<th>Geometric Design of Transportation Facilities</th>
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Geometric design provisions for various transportation facilities as per AASHTO, IRC and other guidelines. Discussion of controls governing geometric design, Route layout and selection, Elements of design - sight distances, horizontal alignment, transition curves, super elevation and side friction. Vertical alignment: - grades, crest and sag curves. Highway cross-sectional elements and their design for rural highways, urban streets and hill roads. At-grade Inter-sections - sight distance consideration and principles of design, channelization, mini round-abouts, layout of round-abouts, Inter-changes: major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, Bicycle and Pedestrian Facility Design; Parking Layout and Design; Terminal Layout and Design.

Text/References Books:


Course Outcomes: At the end of the course, students will be able to:

CO- 1 understand basic concepts of road structures and use of related codes in design provisions.
CO- 2 learn different techniques for analysis and design of highway geometric elements.
CO- 3 understand and design of various highway facilities.
Course Outcomes: At the end of the course, students will be able to:

CO-1 understand the importance of presentation and improve confidence for oral delivery.
CO-2 explore the updated literature in the interested area or topic and interaction thereon.
CO-3 demonstrate scope and problem statement on specific theme.

ELECTIVE-III

<table>
<thead>
<tr>
<th>CODE</th>
<th>Advanced Bridge Engineering</th>
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Introduction, historical review, engineering and aesthetic requirements in bridge design. Introduction to bridge codes. Economic evaluation of a bridge project. Site investigation and planning, Scour factors affecting and evaluation. Bridge foundations - open, pile, well and caisson. Piers, abutments and approach structures; Superstructure - analysis and design of right, skew and curved slabs. Girder bridges - types, load distribution, design. Orthotropic plate analysis of bridge decks. Introduction to long span bridges - cantilever, arch, cable stayed and suspension bridges.

Text/References Books:


Course Outcomes: At the end of the course, students will be able to:

CO-1 ability to use structural codes and standards to model dead, live, snow, wind, and earthquake loads in the design of both super and Sub structures.
CO-2 ability to determine the various structural parameters namely Moments, Shear Stress and mode shapes of continuous system, natural frequency using classical methods.
CO-3 ability to solve statically indeterminate structures namely Super Structures, Sub structures Pile cap, Pier Shaft, Well cap and Well foundation etc.
CO-4 ability to use modern structural analysis software such as MIDAS, SAP.
Aircraft characteristics; planning and site selection; obstruction criteria; air traffic control; runways: orientation, length, geometric standards, capacity, configuration; runway lighting and markings; taxiway and runway pavement design; taxiway: geometric standards, fillets, high speed exit taxiway; apron-gate area and circulation; terminal building - functional areas and facilities; visual aids; drainage; heliports.

Text/References Books:

Course Outcomes: At the end of the course, students will be able to:
CO- 1 understand different components of aircrafts.
CO- 2 study various principles of Air traffic control.
CO- 3 understand the geometric designs of runway, taxiway, apron, hanger, heliports.
CO- 4 learn the planning of different functional units of airport terminal building.


Testing methods for Geosynthetics - Techniques for testing of different index properties, strength properties, Apparent Opening Size, In-plane and cross-plane permeability tests, assessment of construction induced damage, extrapolation of long term strength properties from short term tests.

Reinforced earth walls - Behaviour of Reinforced earth walls, basis of wall design, the Coulomb force method, the Rankine force methods, internal and external stability condition, Construction methods of reinforced retaining walls.

Application in foundations - Binquet and Lee's approach for analysis of foundations with reinforcement layers.

**Use of geosynthetics in embankment** - Basal reinforcement for construction on soft clay soils. Analysis and design concepts.

**Applications of geosynthetics for drainage and filtration** - Different filtration requirements, filtration in different types of soils and criteria for selection of geotextiles, estimation of flow of water in retaining walls, pavements, etc. and selection of geosynthetics.

**Application of geosynthetics in pavement** - Geosynthetics used in unpaved road-function, mechanism, benefit, design- by Giroud-Noiray approach, Paved road - reflection cracking and control using geosynthetics. Use of geosynthetics in railway lines.

**Construction of landfills using geosynthetics** - Different components of modern landfills, collection techniques for leachate, application of different geosynthetics like geonets, geotextiles for drainage in landfills, use of geomembranes and Geosynthetic Clay Liner (GCL) as barriers.

**Text/References Books:**

1. Earth Pressure and Earth Retaining Structures by C. R. I. Clayton, J. Milititsky and Woods
2. Reinforced Earth by T. Ingold
3. Earth Reinforcement and Soil Structures by C. J. F. P. Jones
4. Designing with Geosynthetics by R. M. Koerner
5. An Introduction to Soil Reinforcement and Geosynthetics by G.L SivakumarBabu
6. Reinforced Soil and its Engineering Applications by Swami

**Course Outcomes:** At the end of the course, students will be able to:

CO- 1 select appropriate geosynthetic as per requirement.
CO- 2 apply geosynthetics in different civil engineering project.
CO- 3 design earthen structures with geosynthetic reinforcement.
CO- 4 design pavement with geosynthetics.

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**ELECTIVE-IV**

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<tr>
<th>CODE</th>
<th>Optimization Methods in Engineering Design</th>
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**Text/References Books:**

**Course Outcomes:** At the end of the course, students will be able to:

CO- 1 enable the graduates to understand the concept of optimization, design and develop analytical skills.

CO- 2 enable graduates, apply optimization concept to different civil engineering problems.

CO- 3 summarize the Linear, Non-linear and Geometric Programming.

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<tr>
<th>CODE</th>
<th>Probability Methods in Civil Engineering</th>
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**Introduction**- Role of probability and statistics in civil engineering.

**Random events**- Definition of basic random events; Application of set theory in definition of composite event operations. Probability of events and definition of probability axioms; Solution of real life examples from civil engineering.

**Random variables** - Definition of random variables – discrete and continuous; Probability definitions – PMF, PDF, CDF; Moments and expectations.

**Functions of random variables**- Definitions of probability distributions of functions of single and multiple random variables - exact methods and approximate methods; Moments and expectations of functions – direct and indirect methods.

**Probability distributions Discrete distributions** - binomial distribution, Poisson’s distribution; Continuous distribution – exponential distribution, gamma distribution; Central limit theorem; Normal and lognormal distributions; Extreme value distributions.

**Random samples and statistics** - Examples on various civil engineering problems.

**Sampling distributions** - Chi-square distribution, t- distribution, F distribution.

**Parameter estimation** - Point estimation, confidence interval estimation.

**Hypothesis testing** - Tests of hypotheses on the mean and variance.

**Text/References Books:**

2. Probability and Statistics for Engineers by Ravichandran, J.
3. Applied Statistics for Civil and Environmental Engineers by Kottegoda and Rosso
4. A First Course on Probability by Ross, S.

**Course Outcomes:** At the end of the course, students will be able to:

CO-1 understand probabilistic distribution of geotechnical variables.
CO-2 analyse geotechnical problems using probabilistic perspectives.
CO-3 apply probabilistic methods to geotechnical problems.
CO-4 solve geotechnical problems using statistical methods.

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<th>CODE</th>
<th>Intelligent Transportation System</th>
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</table>


Automated Highway Systems - Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.

**Text/References Books:**

1. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
**Course Outcomes:** At the end of the course, students will be able to:

CO-1 understanding the basic features of intelligent transport system and its application.

CO-2 understand the control system and communication technologies in ITS.

CO-3 understanding the concept of transportation management and automated highway system.