DEPARTMENT OF CIVIL ENGINEERING

Scheme of Instruction and Syllabus of

M.E. (Civil Engineering)

Specialization in

TRANSPORTATION ENGINEERING
(With effect from 2017-2018)

Full time – Part time

UNIVERSITY COLLEGE OF ENGINEERING
(Autonomous) Osmania University
Hyderabad – 500 007, TS, INDIA
(With effect from the Academic Year 2017-2018)

INSTITUTE

Vision

The Vision of the institute is to generate and disseminate knowledge through harmonious blending of science, engineering and technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

Mission

- To achieve excellence in Teaching and Research
- To generate , disseminate and preserve knowledge
- To enable empowerment through knowledge and information
- Advancement of knowledge in Engineering, Science and Technology
- Promote learning in free thinking and innovative environment
- Cultivate skills, attitudes to promote knowledge creation
- Rendering socially relevant technical services to the community
- To impart new skills of technology development
- To inculcate entrepreneurial talents and technology appreciation programmes
- Technology transfer and incubation

DEPARTMENT

Vision

To be as a leading academic department on pace with global standards and contribute to the development of economic, technically viable and useful to societal problems and challenges of civil engineering profession and also contribute to the regional and country's developmental activities.

Mission

- To train the human resources with knowledge base in the field of Civil Engineering so that they can face the challenges of civil and infrastructural engineering problems to provide viable solutions.

- To integrate their understanding and attainable knowledge on the specializations for effective functioning in their profession and useful to the welfare and safety of mankind.

- To enhance the technical knowledge and research aptitude in the domains of various Civil Engineering specializations to serve the society in highly professional manner.

- Produce highly competent and capable professionals and motivated young academicians to provide solutions to real life problems of Engineering and Technology and has apt for continuous learning and dedication towards societal issues.

Programme Educational Objectives:

1. Impart and enrich knowledge in the fields of Highway, Traffic and Transportation Engineering
2. Exposure to the state-of-art testing techniques / methods of analyzing and designs to be adopted for solving different problems related to Transportation Engineering.
3. Facilitate the policy makers and administrators to solve issues pertaining to at different levels such as urban, regional and rural Transportation Environmental Engineering
4. Provide continuing education as per the needs of practicing engineers and academician to enhance their technical knowledge related to design of various facilities pertaining to Transportation Engineering

Programme Outcomes:

1. Acquainted with the principles of Highway, Traffic and Transportation Engineering
2. Familiar with the analysis methods / state of the art testing/construction techniques for application to various problems related to Highway Engineering
3. Able to conduct surveys, study, investigate and design the transportation engineering infrastructure facilities and to provide safe and intelligent transportation systems
4. Proficient in design of various transportation/roadway structures and urban transportation planning systems
5. Advocate the policy makers and administrators to develop and operate regional/rural/urban transportation related issues
6. Encourage the practicing engineers and academicians to enhance their technical knowledge for solving various issues related of Transportation Engineering and for upgrading the transport related infrastructure facilities.

MAPPING OF PEO'S WITH PO'S

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES						
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	
PEO-1	YES	--	--	--	--	YES	
PEO-2	--	YES	--	YES	YES	YES	
PEO-3	--	YES	YES	YES	YES	YES	
PEO-4	YES	YES	YES	YES	YES	YES	
PEO-5	YES	YES	YES	YES	YES	YES	

Scheme & Syllabus for

M.E. (Civil Engineering) Specialization in **Transportation Engineering**

With effect from the academic year 2017-2018

S. No.	Subject Code	Subjects	Periods per Week		Credits	Max. Marks	
			L/T	D/P		Univ. Exam	Sessionals
Core Subjects							
1	CE 1401	Traffic Engineering	3	-	3	70	30
2	CE 1402	Urban Transportation Systems planning	3	-	3	70	30
3	CE 1403	Pavement Materials Characterization	3	-	3	70	30
4	CE 1404	Statistical Techniques	3	-	3	70	30
5	CE 1405	Pavement Systems Engineering	3	-	3	70	30
6	CE 1406	Design of Highway Infrastructure	3	-	3	70	30
Elective Subjects							
1	CE 1411	Analysis of Transportation Systems	3	-	3	70	30
2	CE 1412	Economic Evaluation and Analysis of Transportation Projects	3	-	3	70	30
3	CE 1413	Transportation Modeling and Simulation	3	-	3	70	30
4	CE 1414	Rural and Regional Transportation Systems	3	-	3	70	30
5	CE 1415	GIS and GPS application to Transportation Engineering	3	-	3	70	30
6	CE 1416	Railway Engineering	3	-	3	70	30
7	CE 1417	Behavioral Modeling	3	-	3	70	30
8	CE 1418	Pavement Evaluation Maintenance and Management	3	-	3	70	30
9	CE 1118	Bridge Engineering	3	-	3	70	30
10	CE 1419	Airport Planning and Design	3	-	3	70	30
11	CE 1420	Road Safety and Traffic planning	3	-	3	70	30
12	CE 1312	Ground Improvement Techniques	3	-	3	70	30
13	CE 1421	Highway Construction and Quality Control	3	-	3	70	30
14	CE 1105	Finite Element Methods	3	-	3	70	30

S. No.	Subject Code	Subjects	Periods per Week		Credits	Max. Marks	
			L/T	D/P		Univ. Exam	Sessionals
15	CE 1422	Rural Roads	3		3	70	30
16	CE 0111	Engineering Research Methodology	3	-	3	70	30
Departmental Requirements							
17	CE 1431	Traffic Design and Studio	-	3	2	-	50
18	CE 1432	Highway Materials & Pavement Engg Lab	-	3	2	-	50
19	CE 1433	Seminar - I	-	3	2	-	50
20	CE 1434	Seminar - II	-	3	2	-	50
Dissertation							
21	CE 1435	Project Seminar	4	--	8	--	100
22	CE 1436	Dissertation	6	--	16	200	--

*Minimum of two seminar presentation before final viva required and a comprehensive viva at the end of third semester.

Note: M.E. Dissertation synopsis requires to be approved within four weeks of registration.

CE 1401 *w.e.f. 2017-208*

TRAFFIC ENGINEERING

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives:

- To introduce fundamental knowledge of traffic engineering so that students can understand and be able to deal with traffic issues including safety, planning, design, operation and control.
- To describe basic techniques for collecting and analysing traffic data, diagnosing problems.

Course Outcomes:

Students who successfully complete this course will be able to:

- Use statistical concepts and applications in traffic engineering.
- Identify traffic stream characteristics and Identify level of services
- Design a pre-timed signalized intersection, and determine the signal splits.

UNIT-I

Basic Aspects of Traffic Engineering Aim of traffic engineering, traffic stream components and characteristics, road user characteristics, vehicle characteristics, acceleration characteristics, measure of quality, measures of separation, relationship among traffic parameters and empirical relationships, mechanics of traffic flow, macroscopic approach, microscopic-approach and human factors approach, discrete distributions, binomial distribution, Poisson's distribution, exponential distribution, exponential distribution, normal distribution.

UNIT-II

Traffic Studies, Measurement and Analysis; Volume studies, speed studies, travel forecasting principles and techniques, design hourly volumes and speed, origin and destination studies, presentation of data and analysis, testing of hypothesis relating to improvements.

UNIT-III

Travel Time amid Delay Studies; Various uses, travel time and delay studies, various methods, data collection and analysis, density studies and headways, gap acceptance studies, intersection delay studies, traffic flow theory, queuing theory and simulation models.

UNIT-IV

Capacity Analysis of Traffic Facilities; Uninterrupted facilities, interrupted facilities, Level of Service, quality of service as per HCM, factors affecting LOS, computation of capacity and LOS, Measure of effectiveness, highway capacity and performance characteristics, intersection design.

UNIT-V

Traffic Control, Design and Regulation; Traffic signals, types, principles of phasing, tune diagram, signalized intersection, saturation flow, saturation headway, capacity of lane group, concept of critical lane group, signal timing, phase plan, phase diagram, splitting of phase, clearance interval, pedestrian requirement, guidelines for protected movements, signal co-ordination, emerging themes, inter-modalism, access management, congestion management, environmental impact assessment.

Suggested Reading

1. McShane, W.R., Roess, R.P. and Prassas, E.S., Traffic Engineering. Prentice Hall, Englewood Cliffs, 1997.
2. Highway Capacity Manual, Transportation Research Board, National Research Council, Washington, D.C., 2000.
3. Daganzo, C.R, Fundamentals of Transportation and Traffic Operations, Pergamon, Elsevier Science Inc., New York, 1997.
4. Salter, R.J., Traffic Engineering: Worked Examples, Macmillan, London, 1989.
5. Pignataro, L.J., Traffic Engineering: Theory and Practice, Prentice Hall, Englewood lifts, 1973.

6. Wohl, M. and Martin, B.V, Traffic System Analysis for Engineers and Planners, McGraw Hill, New York, 1983.

7. Drew, D.R., Traffic Flow Theory, McGraw Hill, New York, 1964.

CE 1402 *w.e.f 2017-208*

URBAN TRANSPORTATION SYSTEMS PLANNING

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives:

- To discuss various urban transportation systems planning process and its components
- To understand a variety of travel surveys and data collection procedures
- To review different travel demand forecasting models
- To examine urban land use models and urban goods transportation models

Course Outcomes:

- To describe and evaluate various urban transportation issues and planning methodologies
- To identify the appropriate data collection methods and its procedures
- To demonstrate effective way of understanding trip distribution and mode split models
- To explain various issues related to trip assignment and land use transportation models.

UNIT -I

Components of Transportation System and Challenges; Transportation system definition, urban issues, evolution of planning process, demand and supply, challenges, limitation, measure of effectiveness, measure of collectiveness, traffic problem elements, planning and management, models, planning methodologies. Emerging future trends in Transportation Systems.

UNIT - II

Data Collection and Travel Surveys; Collection of data, design of survey format, organization of surveys and analysis, study area definition, zoning system, types and sources of data, road side interview method, home

interview survey, in-vehicle surveys, sampling, types, various techniques, expansion factors, logical checks, use of secondary sources of data, planning variables, vehicles ownership, projection of data and statistical techniques.

UNIT-III

Travel Demand Forecasting; Various trends, overall planning process, short and long term planning, travel attributes, traffic analysis zones, trip generation, category analysis, concept of gravity model, trip distribution, model split and trip assignment and land use transportation interaction.

UNIT-IV

Trip Distribution and Model Split Analysis; Growth factor models, synthetic pattern models, gravity model, competing opportunity model, intervening opportunity model, linear programming model and abstract mode model, time series models, aggregate and disaggregate models, mode choice, competing modes, mode split models, trip interchange, Toronto transit model, service ratio model, probabilistic models, discriminate analysis, probit analysis and logit analysis, and probabilistic approaches.

UNIT-V

Traffic Assignment and Plan Preparation; Nodes, links, transport. network, coding, rout characteristics, network skims, various methods, judgment, towpath method, diversion curves, network, assignment, all or nothing assignment, capacity restraint techniques, multi-path assignment technique, graph theory, probabilistic assignment model, allocation of traffic, equilibrium assignment, dynamic assignment, land use transport @ .models, Lowry models, Garin Lowry models, ISGLUTI models, mobility and accessibility, five stage models, choice models, urban goods transport, strategies for the evaluation of alternate transportation plans and plan implementation, framework and case studies, preparation of master plans.

Suggested Reading

1. Hutchinson, E.G., Principles of Urban Transport Systems Planning, McGraw Hill, New York, 1974.
2. Ortuzar, J. and Williamson, E.G., Modelling Transport, Wiley, Chinchestor, 1994.
3. Oppenheim, N., Urban Travel Demand Modeling: From Individual Choices to General Equilibrium, Wiley, New York, 1995.
4. Thomas, R., Traffic Assignment Techniques, Avebury Technical, Aldershot, 1991.
5. Taniguchi, E., Thompson, R.G, Yamada, T. and Van Duin, R., City Logistics - Network Modelling and Intelligent Transport Systems, Elsevier, Pergamon, Oxford, 2001.
6. Bruton, M.I, Introduction to Transportation Planning, Hutchinson, .London, 1985.
7. Dickey, J.W, Metropolitan Transportation Planning, Tata McGraw Hill, New Delhi, 1975.

CE 1403 *w.e.f. 2017-2018*

PAVEMENT MATERIALS CHARACTERIZATION

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives

- Understand various tests on subgrade soil, aggregates, bitumen and cement
- Learn bituminous mix and cement concrete mix designs
- Learn basic principles of superpave technology of bituminous mixes

Course Outcomes

- Enable characterization of soils based on index and engineering properties
- Understand subgrade soil strength in terms of standard engineering parameters
- Application of basic principles of mix design of cement concrete and bituminous mixes

UNIT -I

Soil and Aggregate: Soil-Classification methods, Tests: CBR, Consistency, Engineering Properties and Modulus of sub-grade reaction of soil, selection of suitable filter for soils, Triaxial method. Aggregate Origin, Classification, requirements, properties and tests on road aggregates for flexible and rigid pavements. Blending of aggregates, Importance of aggregate shape factor in mix design.

UNIT-II

Methods of Test for Stabilized Soils: Method of sampling and Preparation of Stabilized Soils for Testing, Relation for Moisture content and Dry Density of Stabilized mixes, wetting. Drying, Thawing & freezing tests for compacted soil cement mix, UCS of Stabilized soil, test for: soil bituminous, soil lime and soil fly ash mixes.

UNIT-III

Bitumen, Tar and Bituminous Mix Design; Origin, preparation, properties, requirements, criteria for selection of different binders, Temperature susceptibility, Bitumen test data chart, Stiffness modulus, VanderPoel Nomo graph. Bituminous emulsion and Cutbacks, fillers, extenders, polymers, Crum rubber, and rubber modified bitumen and anti-Stripping agents on pavement performance. Bituminous mix design, binder content, gradation, Engineering properties : Dynamic conditions, Quasi static conditions, Fracture and Fatigue; Marshal stability, Haveem stability test; example problem, static creep test, repeated load test, Resilient & dynamic modulus test, empirical test, simulation test, flexural test, diametric repeated load test, splitting tension test, permanent deformation Parameters
And other properties, Effects use of Geo Synthetics.

UNIT - IV

Introduction to Super pave Technology: Methods of selection of suitable ingredients for super pave method, Gyratory compaction, rolling thin film oven, pressure aging vessel, rotational viscometer, dynamic shear rheometer, bending beam rheometer, direct tension test. Use of super pave perform and grade binder specifications. Comparison between Marshal Mix method and Super pave method. Cement concrete Mixes: Requirements of paving concrete, mix design, Admixtures, Tests on cement Concrete. Recycling bituminous material, fundamental of recycling bituminous material, hot and cold recycling of bituminous material, methods of recycling, equipment use, sites specific material specifications, Design of mixes for recycling of bituminous and concrete pavement surface.

UNIT - V

Cement concrete mixes and recycling bituminous material; cement concrete Mixes: Requirements of paving concrete, mix design, admixtures, and tests on cement concrete. Recycling bituminous material, fundamental of recycling of recycling bituminous material, methods of recycling, equipment use, sites specifications, Design of mixes for Recycling of bituminous and concrete pavement surface.

Suggested Reading

1. Highway Engineering,-Paul H. Wright,. Karen K. Dixon, John Wiley & Sons, 7th edition,2004.
2. Principles and Practices of Highway Engineering, Sharma & Sharma.
3. SRC, DSIR, Bituminous Materials in Road Construction, HMSO publication.
4. Principles of Pavement Design, Yoder E.J, and Witczak M. W. John Wiley & Sons, 1975.
5. ISI and IRC related publications.

CE 1404 *w.e.f 2017-2018*

STATISTICAL TECHNIQUES

Instruction	**3 periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionlas	**30 Marks**
Credits	**3**

Course Objectives:

- To introduce fundamental knowledge of sampling techinue
- To describe basic statistical techniques such as statistical distributons and correlation methods
- To impart knowledge on exact sampling distributions and the tests of significance

Course Outcomes:

Students who successfully complete this course will be able to:

- Use sampling techniques for conducting various surveys related to transportation Engineering
- Decide best fit and develop the regression equations for the given variables
- Applications of sampling distributions in Highway and Traffic Engineering problems.

UNIT-I

Introduction: Frequency distribution; Measures of central tendency; Measures of dispersion; Standard error, Moments (about mean, arbitrary numbers and origin); Skewness; Kurtosis; Sampling-Definitions and Applications; Simple random sampling; Stratified sampling; Systematic sampling; Sample size determination; Applications in Highway and Traffic Engineering

UNIT-II

Statistical Distribution; Probability , Bayes' Theorem; Binomial, Poisson, Exponential and Normal distributions; Fitting of distributions; Mean and variance ; Chi-square test of goodness-of-fit; Applications in Highway and traffic Engineering. Mathematical expectation.

UNIT-III

Regression and Correlation : Linear regression and correlation; Multiple correlation; Multiple correlation coefficient; Standard error of estimate; Analysis of variance; Curvilinear regression; Applications in Transportation Engineering.

UNIT-IV

Multi Variate Data Distributions ; Types of data; Basic vectors and matrices; Simple estimate of centroid, Standard deviation Variance and covariance ; Correlation matrices; Principal component analysis;. Time series analysis. Estimation-Point Estimation in
terval Estimation, Box Plot, Maximum likelihood estimation, Biased & Non Biased Estimation.

UNIT - V

Exact Sampling Distributions and Tests of Significance; Chi-square distribution; students t-distribution; Snedectors F-distribution. Large sample and small sample tests; Tests for single mean. Means of two samples, Proportions, two variances, two observed correlation coefficients, paired T-tests, Applications. Intervals for mean, variance and regression Coefficients; Applications in Highway and Traffic Engineering Problems.

Suggested Reading

1. Basic Statistics - Simpson and Kafks; Oxford and IBH Calcutta,1969.
2. Fundamentals of Mathematical Statistics - Gupta, S.C. and Kapoor, K.V. Sultanchand
3. Multivariate Data Analysis – Cootey W.W & Cochens P.R; John Wiley & Sons

CE 1405 *w.e.f 2017-2018*

PAVEMENT SYSTEMS ENGINEERING

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives:

- Introduction to various factors affecting pavement design
- Concepts of mechanistic empirical methods of flexible and rigid pavements
- Knowledge of pavement evaluation and the related maintenance activities

Course Outcomes:

- Application of basic principles in pavement design
- Assimilation of mechanistic principles for the pavement design
- Explain about appropriate evaluation and maintenance measures for better maintenance of pavements

UNIT - I

Introduction of Pavement Design: Various Factors, Types of Pavements, Functions of Individual Layers, Classification of Axle Types of Rigid Chasis and Articulated Commercial Vehicles, Legal Axle and Gross weights on single and multi units, Tire Pressure, Contact pressure, EAL and ESWL concepts, Equivalent Axle Load Factor, Traffic Analysis: ADT.AADT, Truck factor, Growth factor, Lane, Directional distributions & Vehicle Damage factors, Effect of Transient & Moving loads.

UNIT - II

Stresses in Pavements: Vehicle-Pavement Interaction, Stress inducing factors in flexible and Rigid pavements. Stress in Flexible Pavements: Visco-Elastic Theory and Assumptions. Layered system concepts, Stress solutions for one, two and three layered systems. Fundamental Design concepts. Stresses in Rigid Pavements: Westergaard's theory and Assumptions, Stresses due loading, warping and Frictional Stresses, Friberg's Analysis of Dowel Bars and deflection of dowel-joints.

UNIT- III

Mechanistic Design Methodology for Pavements: General Methodology, Classification of design methods; Pavement Design Concepts; Flexible Pavements: Climatic Models, Structural models, Distress models: fatigue cracking, rutting and thermal cracking models; Rigid Pavements: Structural models, fatigue cracking: load and curling stress, Pumping and Erosion Models, Faulting Models, Joint Deterioration and Punch out models; Need and verification of Flexible and Rigid pavement Mechanistic design procedures.

UNIT - IV

Methods of Pavement Designs: Flexible Pavement Design Concepts, Asphalt Institute Methods with HMA and other Base Combinations, AASHTO, IRC Methods as per IRC37 and IRC:SP:72. Design of Rigid Pavements: Introduction to Calibrated Mechanistic Design Process, PCA, AASHTO, IRC specifications, Introduction to pre-stressed and continuously Reinforced cement Concrete Pavement Design, Dowel bar design and design of tie bars as per IRC:58.

UNIT - V

Pavement Evaluation and Design of Overlays: Types of pavement evaluation: Serviceability concepts, IRI, Quarter Car Model, skid resistance; Pavement Deflection - Different Methods of NDT, Benkelman Beam, LaCroix Deflectometer, Dynaflect, Road Ratar, Rolling Dynamic Deflectometer, Load man, Different Types of Falling Weight Deflectometers (FWD) for evaluation of rigid and flexible pavements. Design of overlays: Types & Design of overlays: Asphalt Institute's Principal Component Analysis, IRC Methods of Overlay Design.

Suggested Readings

1. Design of Functional Pavements, Nai C. Yang, McGraw Hill Publications.
2. Teng, Functional Design of Pavements - McGraw hill - 1990.
3. Concrete Pavements, AF Stock, Elsevier, Applied Science Publishers
4. Principles of Pavement Design, Yoder J. & Witzac Mathew W. John Wiley & Sons.
5. Pavement Analysis & Design, Yang H. Huang, Prentice Hall Inc.
6. Pavement and surfacing for Highway & Airports, Micheal Sargious, and Applied science Publishers Limited.

7. Kadiyali and Lal, Principles of highway engineering, Khanna Publishers, Delhi-6
8. IRC related Codes for Flexible and Rigid Pavements design

CE 1406 *w.e.f. 2017-2018*

DESIGN OF HIGHWAY INFRASTRUCTURE

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives:

- To provide an overview of concepts involved in geometric design of Highways, horizontal & vertical alignment of roads & pedestrian facilities.
- Identify key design elements for intersections.
- Describe usage of traffic control devices

Course Outcomes:

Students who successfully complete this course will be able to:

- Understand the concepts and applications of the elements involved in Highway
  Infrastructure Design.
- Design intersections, bus bays, cycle tracks, subways

UNIT –I

Geometric Design of Highways: Functional classification of Highway system; Design controls - Topography, Driver characteristics, Vehicle characteristics. Traffic, Capacity and Level of Service, Design speed. Objectives of Geometric Design. Road Margins - design specifications; Pavement surface characteristics - Skid Resistance, measurement of skid resistance; Road roughness, measurement of Road roughness; Camber design and standards.

UNIT - II

Horizontal and Vertical Alignment: Sight Distance - SSD, OSD and ISD. Horizontal curves, Super elevation; computing of super elevation; attainment of super elevation; Extra widening on curves; Transition curves - Objectives

and Design. Gradients - Types of Gradients, Design Standards; Summit Curves, Valley curves and Design criteria. Combination of Vertical and Horizontal curves - Grade Compensation. Importance of Sight Distances for Horizontal and Vertical curves.

UNIT- III

Design of Intersections: Types of Intersections; Design Principles for Intersections; Design At-grade Intersections – Channelisation, Objectives; Traffic Islands and Design standards Rotary Intersection - Concept, Advantages and Disadvantages; Grade separated Interchanges - Types, warrants and Design standards as per IRC.

UNIT-IV

Traffic Signs and Road Markings: Types of Road Signs; Guidelines for the provision of Road Signs; Caution Signs, Regulatory signs. Information signs - Design standards. Road markings - Objectives of Road markings; Types of Road Marking, Role of Road markings in Road Safety and Traffic Regulation; Specification for Road Marking Highway Appurtenances-Delineators, Traffic Impact Attenuators, Safety Barriers.

UNIT – V

Pedestrian Elements : Requirements of Pedestrians; Pedestrian facilities on Urban Roads; Cycle Tracks - Guidelines and Design standards; Bus bays-Types and Guide lines-Design of On street and Off street parking facilities - Guidelines for lay out Design. Design of Subways and foot over bridges.

Suggested Reading

1. Principles and Practice of Highway Engineering, L.R.Kadiyali and N.B.Lal, Khanna Publications.
2. Traffic Engineering and Transportation Planning, L.R.Kadiyai, Khanna Publications
3. Highway Engineering, C.E.G.Justo and S.K.Khanna, Nem Chand and Brothers
4. IRC Codes for signs, Markings and Mixed Traffic Control in Urban Areas.

CE 1411 *w.e.f. 2017-2018*

ANALYSIS OF TRANSPORTATION SYSTEMS

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives:

- To discuss various components of urban transportation systems and its innovation
- To understand the concepts of linear programming formulation and various methods
- To review different transportation and assignment formulations and problems
- To examine various non linear programming and decision theories

Course Outcomes:

- To describe and evaluate various transportation systems impacts on society and ecnomy
- To identify the different solutions for linear programming problems including sensitivity analysis.
- To demonstrate effective way of understanding transportation and assignment problems
- To explain various issues related to uncertainty and decision theories.

UNIT – I

Introduction to Transportation Systems: Goals and Scope of Transportation System Analysis, components of transportation system, Transportation innovations, Social and economic impacts of transportation, Decision makers and their options, Vehicle factors and Human factors

UNIT- II

Linear Programming for Transportation: Formulation of Linear Programming, Graphical solutions, Simplex method, revised simplex method, Duality simplex problem, degeneracy, Big M method, sensitivity analysis and computer solutions for linear programming problems.

UNIT- III

Transportation and Assignment Problem: Introduction, mathematical model formulation, Types of Transportation problem - North West corner cell, least cost cell and Vogel's Approximation. Assignment Problem-Introduction, Zero- one programming model. Types of Assignment Problem-Hungerian Method, Branch and Bound Technique.

UNIT-IV

Analysis of Network Flows: Introduction, Types of network techniques - shortest path model, minimum spanning tree model and maximal flow model. Project management- CPM and PERT.

UNIT-V

Non Linear Programming and Decision Theory: Formulation, Characteristics of non-linear programming, convexity of a function, unconstrained single and multivariable problems, constrained optimization, quadratic programming, convex programming-gradient search, frank wolf algorithm and golden search code. Decision theory - introduction, game theory, terminologies of game theory, game with pure strategies, game with mixed strategies, dominance property and graphical solutions.

Suggested Reading

1. Hillier, F.S and Lieberman, G. J, Introduction to Operations Research, McGraw-Hill, Seventh Edition, 2001.
2. Ravindran, A, Philips, D.T and Solberg, J. J, Operations Research: Principles and Practice, John Wiley and Sons, Second Edition 2000.
3. Render, B, Stair, R. M, Quantitative Analysis for Management, rentice Hall of India Private Limited, Seventh Edition, 2000

4. Wayne L. Winston, Operations Research: Applications and Algorithms, Duxbury Press, Third Edition, 1994.
5. Taha, H.A Operations Research: An Introduction, Prentice Hall of India Private Limited, Seventh Edition, 2003.
6. Paneerselvam, R. Operations Research, Eastern Economy Edition, Prentice Hall of India Private Limited, New Delhi- 2002.

CE 1412 *w.e.f. 2017-2018*

ECONOMIC EVALUATION AND ANALYSIS OF TRANSPORTATION PROJECTS

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives:

- Provide knowledge in project formulation and economic evaluation highway infrastructure projects.
- To understand the principles and methods of economic analysis

Course Outcomes:

Students who successfully complete this course will be able to:

- Formulate and prepare Detailed Project Report for a highway project.
- Apply the methods of economic analysis for highway projects.
- Prepare Environmental Impact Assessment Report

UNIT – I

Transportation Projects Formulation and Development: Requirements in project formulation. Components of project, Non- monetary and monetary Criteria in formulation of project. Decision making Criteria input in Project formulation. Preparation of DPR – Guidelines Transport Projects and development: preparation of Project, Highway Planning, Traffic infrastructure, Project formulation, Road Network project development

UNIT- II .

Economic evaluation of Transportation plans: Need for Economic Evaluation; Principles of economic evaluation; Welfare economics; Social costs, Vest change, Rate of return. Value of Travel time Savings; Economic concept of evaluation of travel time savings, Issues connected with evaluation of travel time savings. Vehicle operating costs; Components of

VOC, Road user Cost study in India; Accident costs; Methodologies for economic evaluation of an accident; Factors involved.

UNIT-III

Methods of Economic Analysis: Cash flow diagrams, Time value of money, Inflation, Interest, Depreciation, Cost and benefit components, discounting criteria. Equivalent Uniform Annual cost Method; Present worth of cost method; Equivalent uniform annual net return method; Net-present value method; Benefit cost ratio method; Rate of Return Method; Application of these methods to numerical examples.

UNIT-IV

Analysis of variable costs and Transportation Asset Management: Types of Capital Financing; valuation; Project appraisal by shadow pricing with case studies. Economic Analysis of BOT and BOOT projects and allocations. Introduction and scope of asset management in India.

UNIT-V

Environmental Impact Assessment: Basic concepts, Objectives, Transportation related Environmental Impacts - Vehicular Impacts - Safety and Capacity Impacts - Roadway Impacts – Construction Impacts, Environmental Impact Assessment-Environmental Impact Statement, Environment Audit, Typical case studies.

Suggested Reading

1. Transportation Engineering Economics - Heggie. I.G., McGraw Hill Publishers.
2. Economic Analysis for Highways - Winfrey. R; International Text Book Company.
3. Traffic Engineering and Transport Planning - L. R. Kadiyali, Khanna Publishers.
4. Road User Cost Study, CRRI.
5. Road Project Appraisal for Developing Countries, J. W. Dickey, John Wiley & Sons.
6. Construction Management & Planning, B.Sengupta, H.Guha, Tata McGraw Hill, New Delhi

CE 1413 *w.e.f. 2017-2018*

TRANSPORTATION MODELLING AND SIMULATION

Instruction	**3 periods per week**
Duration of University Examination	**3 hours**
University Examination	**70 marks**
Sessionals	**30 marks**
Credits	**3**

Course Objectives

- Introduction to various models of simulation
- Describe data processing techniques of simulation
- Explain exact sampling distributions and testing

Course Outcomes

- Understand various models of simulation
- Build models for transportation simulation
- Evaluate and validate the models

UNIT-1

Introduction of Modeling: Fundamentals of systemic approach. System modeling, Model structure, Variables, controllable variables, uncontrollable variables, parameters, coefficients and other statistical methods for testing of models and data.

UNIT - II

Classification of Models; Classification of models - Linear models, Non-linear models, Time-invariant models, Time-variant models, State-space models, Distributed. parameter models. System Synthesis- - Direct and Inverse Problems, Role of optimization and Examples from transportation engineering.

UNIT-III

Preliminary Data Processing: data collection, Regression Analysis-Linear multiple regression analysis; Analysis of residues, Tests of goodness of fit. Spatial Distribution- Polynomial surfaces, Spline functions, Cluster. analysis

and Numerical production of contour maps. Time Series Analysis-Auto-cross. correlation analysis, Identification of trend, spectral analysis, Identification of dominant cycles, smoothening techniques, Filters and forecasting.

UNIT-IV

Model Building: Choice of Model Structure- A priori considerations, Selection based upon preliminary data analysis, Comparing model structures. Model Calibration- Role of historical data, Direct and Indirect methods of solving inverse problem.-Model Validation.

UNIT-V

Simulation; Random variables, Basic concepts. Probability density and distribution functions, Expectation and standard deviation of discrete and continuous random variables and their functions, Covariance and correlation, commonly used theoretical Probability distributions: Uniform, Normal, Binomial, Poisson, Negative exponential. Fitting distributions to raw data: Chi-square and Kolmogrov-Smirnov's tests of the goodness of fit. Central limit theorem, various algorithms for generation of Random numbers. Queuing theory: Elements, Deterministic queues. Applications of Monte, Carlo simulation:" Basic concepts. Generation-of synthetic observations, - Statistical interpretation of the output, Evaluation of definite integrals and examples.

Suggested Reading

1. Bratley, P., Fox B. L., Schrage, L. E. B., Guide to Simulation, Springer-Verlag, New York 1983.
2. Leigh, J. R., Modeling and Simulation, Peter Peregrinus, London, 1983.
3. Bernard, Z., Theory of Modeling and Simulation, John- Wiley, New York, 1976.
4. Ortuzar, J. and Willumsen, L.G, Modeling Transport, Wiley, Chinchestor, 1994.
5. Hansher, D. A., and Button. K. J., Handbook of Transport Modeling, Pergamon, Oxford, UK, 2000

CE 1414 *w.e.f. 2017-2018*

RURAL AND REGIONAL TRANSPORTATION SYSTEMS

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives:

- To impart knowledge on planning and development concepts
- To analysis data for transpiration needs forecasting
- To make the students capable for analysis of frieght transportation needs

Course Outcomes:

- Development of transportation systems based on the analysis of population data
- Development of population forecasting models
- Can be able to analyze freight transportation data for future planning and management purposes

UNIT – I

Planning and Development concepts: Planning of Rural roads, concept of network planning, rural road plan, road alignment and surveys, Governing factors in route selection, factors considered for alignment.
Regional analysis and development concepts

UNIT-II

Methodology and Models for Rural Transportation System: The role of transportation planning in the overall regional transportation system. Methodology and models for regional transportation system Planning and implementation framework. Statistical methods for validation of models.

UNIT-III

Population forecasting Models; Various methods of forecasting models: Cohart survival model, Interregional cohart survival model and Input output models. Rural transport planning process.

UNIT-IV

Freight transportation analysis: Survey methods, data collection, forecasting of freight transportation, analysis, model development, truck terminal planning and management. Planning and management of freight transportation.

UNIT – V

Regional transportation case studies; Various case studies in regional and rural transportation planning.

Suggested Reading

1. D. Salvo Perspectives in Regional Transportation Planning, Lexington Books, USA, 1974.
2. Mishra Sundaram and Prakash Rao, Regional Development Planning in India, Vikas Publishing House Pvt. Ltd., 1974.
3. Seminar, Road -and Road Transport in Rural Areas, Nov. 19-21, 1985, CRRI, New Delhi.

CE 1415 *w.e.f. 2017-2018*

GIS AND GPS APPLICATION TO TRANSPORTATION ENGINEERING

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives:

- Description about various spatial and non-spatial data types and data base management methods
- Development of the concepts and professional skills in utility of GIS techniques
- Enhancement of knowledge of GIS to transportation field problems

Course Outcomes

- GIS related data acquiring and processing that is associated with geographic locations
- Application of GIS techniques in the decision support systems useful for decision makers and community services in Transportation field.
- Utility of GIS techniques in the fields of natural resource management, environment, transportation planning and development, etc.

UNIT -I

Introduction to GIS; Introduction, GIS over view, use of GIS in decision making. Data processing, components of GIS, The GIS and the organization, Data input-Key board entry, Manual digitizing, scanning, Remotely and sensed data, existing digital data, census related data sets, Data output - Hard copy and soft copy devices.

UNIT-II

Data Acquisition and Data Management; Platforms, sensors used for the remote sensing data acquisition, data processing, radiometric, geometric corrections. Components of data quality - Micro level, Macro level components. Sources of error, a note about data accuracy.
Management: The data base approach, 3 classic data models, Nature of geographic data, spatial data models. Databases for GIS

UNIT- III

GIS Analysis and Functions;. Organizing geographic data for analysis, Maintenance and analysis of the spatial data and non-spatial attribute data and its integration output formatting.

UNIT-IV

Implementation of GIS; Awareness, Developing system requirements, Evaluation of alternative systems, System justification and Development of an implementation plan, System acquisition and start-up, Operation of the system.

UNIT-V

Application of GIS for Transportation Engineering; Intelligent information system for road accessibility study, GIS database design for physical facility planning. Decision support systems for land use planning.GIS applications in environment impact assessment, GIS based Highway alignment, GIS based road network planning, GIS based traffic congestion analysis and accident investigation

Suggested Reading

1. GIS for Urban & Regional Planning, Scholten & Stillwen 1990,Kulwer Academic
   Publisher
2. Lillesand Kiefer, Remote Sensing Principles and Interpretation, John Wiley & Sons, New York, 2000.

3. Paul J. Gibson, and Clare H. Power, Introductory Remote Sensing,British Library, London, 2000.
4. Stan Arnoff, Geographic Information Systems, A Management Perspective, Canada, 1995
5. Hand book on T.E. Myer Kutz, Editor McGraw Hill, 2004.

CE 1416 *w.e.f. 2017-2018*

RAILWAY ENGINEERING

Instruction	**3 periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives:

- To understand basic terminology related to Railway Engineering
- To know the various components of track
- To understand the various methods of signaling interlocking methods

Course Outcomes:

- Develop and design of railway tracks with geometric standards
- Investigate and explore the failures of railway embankments and suggest remedial measures
- Design points and crossings with modern signaling system

UNIT-I

General Features of Railways: development in Indian railways, modes of transport, organization of Indian railways, finances and their control commission of railway safety, long term planning process, classification of railway lines, general features of Indian railways, impartment statistics.,.Alignment of railway lines, railway track gauge, engineering surveys.

UNIT-II

Rails, Sleepers, Track and Track Stresses; requirements of good track, maintenance of permanent way, track as an elastic structure, coning of wheels, tilting of rails. Functions of creep, creep adjuster, measures to reduce creep. Sleepers, requirements, sleeper density, types; wooden, steel channel, steel of rails, types, requirements for an ideal rail section, rail manufacture, rail wear, defects in rails, rail failure, and rail flaw detection. Creep: causes, effects of creep, measurement trough, cast iron, concrete etc.

UNIT-III

Geometric Design of Railway Track; Necessity of Geometric design details of geometric design of track, circular curves, super elevation, transition curve, reverse curve, extra clearance of curves, widening of gauge on curves, vertical curves, cutting rails on curves, check rails on curves.

UNIT-IV

Sub grade Formation and Ballast; Slope of formation, execution of earthwork in embankments and cuttings, blanketing Material, Failure of railway embankment, site investigations. Ballast: functions, types, sizes of ballast, requirement, design of ballast section, collection and transportation of ballast, methods of measurement, laboratory tests for physical properties of ballast. Guidelines for provision of sub-ballast.

UNIT – V

Points and Crossings, Level Crossings, Signaling and Interlocking; Crossings, switches, number and angle of crossing,. reconditioning of worn out crossings, turnouts, turnout with curved switches, layout of turnout, trends in turnout design on Indian Railways, inspection and maintenance of points and crossings. Level crossing: types, dimensions, accidents and remedial measures, maintenance of LC, inspection-LC by PWI. Signaling and interlocking: types, signaling systems, systems for controlling train movement, interlocking, modern signaling installations.

Suggested Reading

1. Chandra, S.and Agarwal.M.M. "Railway Engineering". Oxford University Press, New Delhi, 2007.
2. Rangwala, K. S. "Principles of Railway Engineering". Charotar publishing House, India (1991)

CE 1417 *w.e.f. 2017-2018*

BEHAVIOURAL MODELLING

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives:

- To review the background of discrete choice analysis and its applications to transportation.
- To understand the frame work of choice theories and probabilistic theories
- To establish aggregate forecasting techniques and various sampling theories.
- To discuss multidimensional choice sets and estimation of the nested logit model.

Course Outcomes:

- To demonstrate the methods of estimation of discrete choice theory and statistics for model estimation
- To explain binary logit model and multinomial logit models including random utility theory
- To identify various aggregate forecasting techniques and comparing with traditional methods
- To describe derivation of nested logit model from generalised extreme value model

UNIT -I

Introduction & Review of the statistics of Model Estimation: Background of Discrete Choice-analysis, Transportation applications of Discrete Choice Analysis. The estimation problem, small sample properties, asymptotic properties, methods of estimation, key statistical tests.

UNIT-II

Theories of Individual Choice Behaviour: Introduction, A frame work for choice theories, rational behaviour, economic consumer theory, discrete choice theory, probabilistic theory.

UNIT-III

Binary and Multinomial Choice Models: Random utility theory, binary choice models, examples, maximum likelihood estimation, examples. Theory of multinomial choice, multinomial logit models, properties logit, specification of multinomial logit model, estimation of multinomial logit, examples of estimation results.

UNIT-IV

Aggregate Forecasting Techniques & Theory of sampling: Problem of aggregation across individuals, typology of aggregation methods, a comparison of methods for aggregate forecasting. Basic sampling concepts, sampling strategies, overview, choosing a sample design for discrete choice analysis.

UNIT-V

Nested Logit and Models of Travel Demand: Multidimensional choice sets, estimating the nested logit model, multinomial probit model, measure of accessibility, derivation of the nested logit model from the generalized extreme value model. Components of travel demand modeling process, behavioural theory, measurement, statistical model structure and estimation.

Suggested Reading

1. Ben-Akiva, M and Lerman, S. R. "Discrete Choice Analysis: Theory and Application to Travel Demand'". The MIT press, Cambridge, Massachusetts, London.
2. Train, K. E. "Discrete Choice Methods with Simulation". Cambridge University Press, London.

PAVEMENT EVALUATION, MAINTENANCE AND MANAGEMENT

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives:

- Understand the basic working principles of various equipment used for pavement evaluation
- Describe design aspects of overlay thickness of pavements
- Impart knowledge regarding the different types of distresses and LCCA of pavements

Course Outcomes:

- Awareness about various NDT equipment used for pavement evaluation
- Applications of pavement management principles
- Knowledge regarding the different levels maintenance treatment options

UNIT-I

Pavement Inventories and Evaluation: Purposes, functional Evaluation: Serviceability concepts, Distress types: Bituminous and Concrete pavements; Visual Rating; PSI; Methods of Measuring Roughness: Response type & Profile type; IRI: Quarter Car Model, Riding Number; Pavement Safety Evaluation: Skid Resistance, measurement of skid, skid resistance, Change of Skid resistance with time, traffic and climate; Control of Skid Resistance; Distress Modes - Cracking, Rutting etc.

UNIT-II

Structural Evaluation: Pavement Deflection: Different Methods of NDT(Working Principles): Benkelman Beam, LaCroix Deflectometer, Dynaflect, Road Ratar, Rolling Dynamic Deflectometer, Loadman, Different Types of Falling Weight Deflectometers (FWD) for evaluation of rigid and flexible pavements; Factors influencing deflections, Back-calculation of

Pavement Layer Moduli and detection of loss of bonding of cement concrete pavements using FWD data; Destructive Structural Evaluation; Pavement Performance Prediction Models for Flexible and Rigid Pavements.

UNIT-III

Pavement Management System (PMS): Components of PMS and their activities; Major steps in implementing PMS; Inputs; Design construction and maintenance; Rehabilitation and Feedback systems; Examples of HDM and RTIM packages; Evaluating alternate strategies and Decision criteria based on Structural section, Material type, Construction policy, maintenance policy, Overlay and seal coat; Pavement performance prediction models; Techniques and Tools, Expert Systems and Pavement Management.

UNIT - IV

Pavement Maintenance Management: Components of maintenance management and related activities-Network and project level analysis-Budgeting; Prioritization Techniques and Formulation of Maintenance Strategies, Pavement Preservation. Pavement Life Cycle Cost Analysis (LCCA): Cost Components, Methods of LCCA-Components involved, Brief Description - Items considered - Case studies.

UNIT - V

Highway Maintenance: Need of Highway maintenance, methods of maintenance for flexible and rigid pavement layers; WBM, Bituminous and Cement Concrete pavements.

Suggested Reading

1. Haas and Hudson W.R. Pavement management systems - McGraw Hill publications
2. Sargious, M.A. - Pavements and surfacing for highways and airports - Applied Science Publishers Ltd.
3. Bridge and Pavement maintenance - Transportation Research RecordNo.800,TRB
4. Shahin M.Y. 1994 - Pavement Management for airports, roads and parking lots
5. Bent Thagesan, 1996- Highway and Traffic engineering for developing countries.
6. Principles of Pavement Design, Yoder J. & Witzac Mathew W.,John Wiley & Sons.
7. Pavement Analysis & Design, Yang H. Huang, Prentice Hall Inc.

8. Hand Book of Highway Engineering, Rober F.Baker, Editor, L.G Byrd D.Grarit Mikle, Associate Edotor, Van Nostrand Reinhold Comp, 1.975.
9. Relevant IRC Code books
10. AASHTO Guide for Design of Pavement Structures, published by American Association of State Highway and Transportation Officials, 1993.

CE 1118 *w.e.f. 2017-2018*

BRIDGE ENGINEERING

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives:

- Understand the basic concepts of welded plate girder design
- Learn the basic principles of gantry girder design
- Study the various types of bridges, bridge bearings and their design procedures

Course Outcomes:

- Analyze and design the plate girder and gantry girder
- Design the railway steel bridges and bridge bearings
- Apply the design principles of prestressed concrete bridges

UNIT-I

Concrete Bridges: Introduction-Types of Bridges-Economic span length Types of loading-Dead load-live load-Impact Effect–Centrifugal force-wind loads-Lateral loads-Longitudinal forces-Seismic loads-Frictional resistance of expansion bearings-Secondary Stresses- Temperature Effect-Erection. Forces and effects-Width of roadway and footway-General Design Requirements.

UNIT-II

Solid slab Bridges and Girder Bridges: Introduction-Method of Design: Solid Slabs Spanning in One-Direction, Cantilever; Dispersion of Loads Along the Span. Design Principles of Solid Slab Bridge with numerical examples. Introduction, Method of girder bridge Design: Pigeaud's Theory and Courbon's Theory with numerical examples as per IRC class AA tracked vehicle, Class AA wheeled vehicle, Class A loading.

UNIT-III

Continuous Bridges: Introduction-Span lengths -Analysis of continuous bridges-Decking of girders with constant Moment of Inertia- Continuous

bridges with variable Moment of Inertia-Method of Analysis- Girders with Parabolic Soffit-Method of plotting Influence lines-Girders with straight Haunches-Design steps for continuous Bridges.

UNIT-IV

Analysis of Bridge Decks and sub structure of Bridges: Harmonic analysis and folded plate theory-Grillage analogy-Finite strip method and FEM. Substructure-Beds block-Piers-Pier Dimensions-Design loads for piers-Abutments-Design loads for Abutments.

UNIT-V

Pre-Stressed Concrete Bridges: Basic principles-Method of Pre-stressing-Pre-tensioning and Post-tensioning-Comparison–Freyssinet Method - Magnel-Blanet System -Lee-Mc call system –Basic Assumptions - Losses in Prestress equation based on Initial and final stress conditions -Cable Zone-Design of sections-Condition of first crack-Ultimate load design-Shear-Vertical Prestressing -Diagonal Tension in I-section-End Block-Mangel's method-Empirical Method- Mild steel reinforcement in prestressed concrete member-concrete cover and spacing of pre-stressing steel-slender beams-composite Section-Propped-Design of propped Composite Section-Unpropped composite section-Two-Stage Prestressing -shrinking stresses – Genera Design requirements for Road Bridges With Numerical Examples.

Suggested Reading

1. Design of Concrete Bridges by M. G. Aswani, V. N. Vasirani and M. M. Ratwani
2. Bridge Deck Behaviour by E. C. Hambly
3. Concrete Bridge Design and Practice by V. K. Raina
4. Wai-Fah Chen Lian Duan, Bridge Engineering Handbook, CRC Press, USA, 2000.
5. R. M. Barker, and J. A. Puckett, Design of Highway Bridges, John Wiley & Sons, New York, 1997.
6. P. P. Xanthakos, Theory and Design of Bridges, John Wiley & Sons, New York, 1994.

CE 1419 *w.e.f. 2017-2018*

AIRPORT PLANNING AND DESIGN

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives:

- To understand basic terminology and standards relate Airport Engineering
- To know the various componenets of airport and runway components
- To undertand the various methods of air travel demand analysis

Course Outcomes:

- Conduct surveys, develop and design new airports with ICAO/FAA geometric standards
- Investigate and explore the failures of runway pavements and suggest remedial design measures
- Develop plans for installation of various types of devices pertaining to Air Traffic Controls

UNIT-I

Airport Planning: Growth of Air Transport, Technological Developments, Institutional Development for Planning, Regulatory Practices; Aircraft characteristics related to airport planning and design, Future trends in Air craft design and Airport Planning; Airport master plan, site selection, planning surveys etc. Airport Obstructions: Zoning Laws, Classification, Approach and Turning Zones.

UNIT-II

Runway Design and Airport Capacity: Runway Orientation, Basic Runway Length and Factors affecting, Correction for elevation, temperature and gradient as per ICAO and FAA, Run way Geometric Design. Airport Capacity: Classification and Standards; Capacity of Airport, Runway, Taxiway and Gate; Delays; Configuration of Airport and Configuration; Runway Intersection Design; Terminal Facilities and Standards: Planning Concepts. Taxiway Design: Factors affecting Taxiway Design, Geometric

Design as per ICAO, Exit taxiways, Fillets, Separation clearance, Holding Apron, Turn Around.

UNIT-III

Design of Airport Pavements: Design factors, Calculation of ESWL with different wheel load configurations and methods, Repetition of loads, failure criteria; Flexible Pavements Design: US corps of Engineers Method, FAA method; Rigid Pavement Design methods: US corps of Engineers method, PCA Method, FAA method, LCN Method and CAN-PCN System.; Overlays; Drainage: Surface and subsurface methods, filter materials, Special characteristics and requirements of Airport Drainage. Airfield Pavement Maintenance and Rehabilitation: Need, Failures, Evaluation of flexible and Rigid Pavements, Strengthening of Airfield Pavements and maintenance operations.

UNIT-IV

Air Travel Demand Analysis: The Demand Analysis, Microanalysis of Air Travel Demand, Calibration of Macro analysis of Air Travel Demand, Disaggregate Models Route Frequency planning. Air travel choice Models, Simultaneous Models of Demand and supply. Optimal Route Frequency Planning.

UNIT-V

Air Traffic Controls (ATC): Visual Aids: marking and lighting; Need, Network and Aids for ATC, Radio equipment; Design of Heliports and STOLPORTS: Design Factors, Planning, Site selection. Geometric Designs, Visual Aids.

Suggested Reading

1. Principles of Pavement Design, Yoder E.J. and Witczak M. W. John Wiley &-Sons, 1975.
2. Elementary Hand Book of Aircraft Engines, A. W. Judge, Chapman and Hall ltd, London.
3. Airplanes Structures, A.S. Nil.es and J.S. Newell, M. W. John Wiley & Sons, New York.
4. Relevant IRC codes.
5. Air Port Engineering, Norman Ashford and Paul H Wright, M. W.John WHey & Sons.
6. The Planning and Design of Airports, Robert Horojeff, McGraw Hill Book Co..
7. Airport Planning and Design, S.K. Khanna, Arora and S.S. Jain, Nem Chand & Bros. Roorkee.

CE 1420 *w.e.f. 2017-2018*

ROAD SAFETY AND TRAFFIC MANAGEMENT

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives

- Introduction to various factors considered for road safety and management
- Explain the road safety appurtenances and design elements
- Discuss the various traffic management techniques

Course Outcomes

- Prepare accident investigation reports and database
- Apply design principles for roadway geometrics improvement with various types of traffic safety appurtenances/tools
- Manage traffic including incident management

UNIT - I

Road accidents: Causes, scientific investigations and data collection, Analysis of individual accidents to arrive at real causes, statistical methods of analysis of accident data, Basic concepts of Road accident statistics,Safety performance function: The empirical Bayes method Identification of Hazards road location. Application of computer analysis of accident data.

UNIT-II

Safety in Road Design: Operating the road network for safety, highway operation and counter measures, road safety audit, principles-procedures and practice, code of good practice and checklists, vehicle design factors & Driver characteristics influencing road safety.

UNIT - III

Road Signs and Traffic Signals: Classification, Location of Signs, measures of sign effectiveness, Types of visual perception, sign regulations, sign visibility, sign variables, Text versus symbols. Road Marking: Role of Road markings, Classification, visibility. Traffic Signals: Need, Signal face. Illumination and location of Signals, Factors affecting signal design,

pedestrians' safety, fixed and vehicle actuated signals. Design of signa1s, Area Traffic control. Delineators, Traffic Impact Attenuators, Road side rest areas, Safety Barriers, Traffic Aid Posts.

UNIT-IV

Traffic Management Techniques: Integrated safety improvement and Traffic Calming Schemes, Speed and load limit, Traffic lights, Safety cameras, Tests on driver and vehicles, pedestrian safety issues, Parking, Parking enforcement and its influence on Accidents. Travel Demand Management; Methods of Traffic management measures: Restriction of Turning Movements, Oneway streets, Tidal Flow Operation Methods, Exclusive Bus Lanes and Closing Side-streets; Latest tools and techniques used for Road safety and traffic management. Road safety issues and various measures for road safety; Legislation, Enforcement, Education and Propaganda, Air quality, Noise and Energy Impacts; Cost of Road Accidents.

UNIT-V

Incident Management: Introduction, Characteristics of Traffic Incidents, Types of Incidents, Impacts, Incident management process, Incident traffic management; Applications of ITS: Motorist information, Equipment used; Planning effective Incident management program, Best practice in Incident management programs. National importance of survival of Transportation systems during and after all natural disasters especially cyclones, earthquakes, floods etc and manmade disasters like sabotage, terrorism etc.

Suggested Reading

1. Guidelines on Design and Installation of Road Traffic Signals,IRC:93.
2. Specification for Road Traffic Signals, IS: 7537-1974.
3. Principles and Practice of Highway Engineering by L.R. Kadiyali andN.B.Lal.
4. Hand book of T.E. Myer Kutz, Editor McGraw Hill, 2004.

CE 1312 *w.e.f. 2017-2018*

GROUND IMPROVEMENT TECHNIQUES

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives

- To understand the objectives, necessity and scope of ground improvement techniques
- To learn different methods of insitu densification of cohesive, cohesionless soils
- To learn the classification, functions and applications of Geosynthetics in ground improvement
- To learn the process of identification of necessity for ground improvement, finding alternative methods and recommendation of the ideal technique through case studies

Course Outcomes

- Ability to understand the necessity of ground improvement and potential of a ground for improvement
- To gain comprehensive understanding about the improvement of in-situ cohesive soils as well as Cohesionless soils
- Competence to analyse an in-situ ground, identification of ground improvement techniques feasible, selection of the ideal method, its planning , design, implementation and evaluation of improvement level

UNIT - I

Ground Modification: Need and objectives of Ground Improvement, Classification of Ground Modification Techniques - suitability and Feasibility, Emerging Trends in ground improvement.

UNIT - II

Mechanical and Hydraulic Modification: Methods of compaction, Shallow compaction, Deep compaction techniques - Vibro floatation, Blasting, Dynamic consolidation, pre-compression and compaction piles, Field compaction control. Hydraulic Modification: Methods of dewatering- open sumps and ditches, Well-point system, Electro-osmosis, Vacuum dewatering wells; pre-loading without and with sand drains, strip drains and rope drains.

UNIT-III

Physical and Chemical modification: Stabilisation with admixtures like cement, lime, calcium chloride, fly ash and bitumen, Grouting: categories of grouting, Art of grouting, Grout materials, Grouting techniques and control.

UNIT-IV

Reinforced Earth Technology: Concept of soil reinforcement, Reinforcing materials, and Backfill criteria, Art of reinforced earth technology, Design and construction of reinforced earth structures.

UNIT -V

Soil Confinement Systems and Miscellaneous techniques: Concept of confinement, Gabbion walls, CRB walls, Sand bags, Evergreen systems and fabric formwork. Miscellaneous Techniques: Design, Construction and applications of stone columns lime columns and cofferdams, Applications of Geo-textiles in Highway construction.

Suggested Reading

1. Manfred R.Hansmann - Engineering principles of ground modification - Me Graw-Hill pub. Co., New York
2. Robert M.Koerner - Construction and Geotechnical methods in Foundation Engineering- Mc.Graw-Hill Pub. Co., New York
3. Winterkorn and Fang - Foundation Engineering Hand book -Van Nostrand Reinhold Co., New York.
4. Aris C.Stamatopoulos & Panaghiotis C.Kotzios - Soil Improvement by Preloading - John Wiley & Sons Inc. Canada
5. R. Pumshothama Rao - Ground Improvement Techniques - LaxmiPublications (P) Limited.

CE 1421 *w.e.f. 2017-2018*

HIGHWAY CONSTRUCTION AND QUALITY CONTROL

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
University Examination	**70 Marks**
Sessionals	**30 Marks**
Credits	**3**

Course Objectives:

- To introduce the concepts related to construction planning and management.
- The students are expected to understand the principles and techniques of various methods of pavement construction.
- Understand the quality control methods and techniques for flexible and rigid pavements

Course Outcomes:

Students who successfully complete this course will be able to:

- Plan and control construction related activities.
- Gain knowledge about different methods and techniques of pavement construction.
- To perform quality control checks on pavements.

UNIT - I

Construction Planning and Management: Need and significance of Highway construction planning, Role of labour and machinery in construction; Time, cost and resource management of projects for planning, scheduling, Control and forecast using networks with Bar chart, Critical Path Method (CPM), PERT; Personal, material and finance management, Safety Engineering. Various types of equipment for excavation, grading and compaction - their working principle, advantages and limitations; cement concrete and Bituminous concrete plants.

UNIT - II

Construction of Base, Sub base & Drainage layer: General construction, Earth work, Roadway and Drain excavation, Excavation and blasting,

Embankment construction, Selection and proportioning of soil elements. Construction of: Earth & Roads, Gravel base, Cement stabilized sub bases, WBM, WMM, Unbound cement bases, Shoulders,, Turfing sand, Drains, Sand wicks, Rope drains, Geo-textile drainage, Pre loading techniques. Field Control checks.

UNIT-III

Bituminous Pavement Construction: Preparation and laying of Tack Coats, Seal coats, Slurry seal coats, Classification of hot mix paving, Bituminous Macadam, Penetration macadam, Built-up spray grout, Semi dense Asphalt concrete, Interface treatment and overlay construction, IRC specifications, Determination of job mix formula, Types of Mix plants, Introduction to Mechanical Mixers, Pavers, spreaders and Finishes.

UNIT-IV

Cement Concrete Construction: Construction of Cement roads Manual and Mechanical methods, Use of distributed steel reinforcement, interlocking block pavements, construction: interlocking block pavements, joints in concrete and reinforced concrete pavements and overlay construction, Drainage, Maintenance of roads, Construction of: Hill Roads, Desert Roads and Roads in swampy & Water-logged Areas'and Black cotton Soils, Bridge construction and Inspection Equipment.- related equipment.

UNIT - V

Quality Control: Introduction, Requirements of a Highway Project,Pre requisite, Specifications and Code of Practice, Quality assurance, Quality Control - ISO 9000, Elements of Quality Assurance System, Distinguish Quality Assurance & Quality Control, Sampling techniques, Tolerance & Controls related to profile and compaction, methods in quality control.

Suggested Reading

1. Pavement and surfacing for Highway & Airports, MichealSargious, Applied science Publishers Limited.
2. IRC Codes for Flexible and Rigid Pavements design
3. Highway Engineering, Paul H.Wright, Karen K.Dixon, John Wiley& Sons,.7th edition.2004.

4. Construction planning. Equipment and methods, Peurifoy R.C,and C.J.Shexnaydr, McGraw Hill, 2002

5. TheAsphalt Handbook, MS-4, Asphalt Institute, Maryland, 1989

6. IRC: Special Publication 11, Handbook on Quality Control for Construction of Roads and Ruwaways, IRC, 1988

7. Specifications for Hotmix plant, IS:5890-1970andIS:3066-1965,New Delhi.

CE 1105 *w.e.f. 2017-2018*

FINITE ELEMENT METHODS

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
Semester End Evaluation	**70 Marks**
Continuous Internal Evaluation	**30 Marks**
Credits	**3**

Course Objectives:

- Learn the rudiments of finite element analysis.
- Study the fundamentals of domain discretization, interpolation, application of boundary conditions, assembly of global matrices, and solution of the resulting algebraic systems.
- Explain the core concepts of variational and weighted residual methods in FEM.
- Derive the element stiffness matrix for 1-D, 2-D and 3-D problems.
- Formulate the simple structural problems in to finite elements.

Course Outcomes:

- Build and analyse the FEA models for various engineering problems.
- Identify the information requirements and sources for analysis, design and evaluation.
- Use the standard finite element software to solve the structural engineering problems.
- Interpret the results obtained from FEA software, not only in terms of conclusions but also awareness of limitations.

UNIT – I

Introduction to FEM: Types of problems – Types of materials – Elastic, inelastic situations – Types of forces - Body forces, surface traction, point loads – Deformable bodies – Types of deformations – Homogeneous, non homogeneous problems – Equations of equilibrium for elastic 2-D, 3-D continua - Equilibrium equations for 2-D, 3-D boundary elements – Boundary conditions – Strain-displacement relation for 2-D, 3-D problems – Stress-strain relation for 2-D, 3-D problems – Plane stress, plane strain

problems.
Virtual work formulation: Application to problems of plane trusses with static indeterminacy not exceeding three.

Finite difference method with central differences: Solving ODE‘s and PDE‘s with central differences - Application to beam and plate bending problems of simple geometry.

UNIT – II

Variational formulation: Finite element formulation - Stationarity of functional - Given the functional or differential equation – Number of elements limited to two.

1-D Elements: Strain-displacement relation matrix - Stiffness matrix - Minimum potential energy approach - Rayleigh-Ritz Method - Introduction to natural coordinates - Stiffness matrix of second order bar element - Axial bar subjected to point loads, body forces and surface traction forces - Problems with kinematic indeterminacy not exceeding two.

2-D Triangular elements**:** Displacement models - Criterion for convergence - Geometric invariance - Conforming and non-conforming elements - 3-node triangular (CST) element - Strain-displacement matrix - Area coordinates, shape functions - Element stiffness and load matrices – Assembly of global stiffness and load matrices - Problems with kinematic indeterminacy not exceeding three.

2^{nd} Order triangular elements: Shape functions – Degradation technique - Strain-displacement matrix - Expression for stiffness matrix - Load matrices due to body forces and surface traction.

UNIT – III

Iso-parametric elements: Quadrilateral elements: **S**hape functions using natural coordinates - Strain- displacement matrices - Load matrices for body force and surface traction - Stiffness matrix - Load matrices for 4-node quadrilateral elements - Gauss quadrature of numerical integration - Problems with rectangular elements, kinematic indeterminacy not exceeding three.

2^{nd} Order Quadrilateral elements: - Shape functions for 2^{nd} order

quadrilateral elements and for elements of with serendipity - Strain-displacement matrix - Load matrices for body force and surface traction.

UNIT – IV

Method of weighted residuals: Galerkin's method of weighted residuals: Application to problems of mathematics and structural engineering, number of trial functions not exceeding two.

Galerkin's finite element method: Weak form of trial function - Application to problems of mathematics and structural engineering, number of elements limited to two.

Axi-symmetric problems: Strain-displacement matrix - Stress-strain relationship - Stiffness matrix for 3-noded ring element - Load matrices for body force and surface traction - Problems with kinematic indeterminacy not exceeding three.

UNIT – V

Tetrahedron elements: Volume coordinates, Strain-displacement matrix - Stiffness matrix - Load matrices due to body force and surface traction - Introduction to hexahedron (brick) elements.
Non-linear Finite element analysis: Introduction – Problems with material non-linearity – Problems with geometric non-linearity – Problems with both material and geometric non- linearity.
Introduction to MSC Nastran: Illustration on different modules of Nastran - Structural engineering applications of the package - Creation of a simple 1-D model, 2-D model and a 3-D model - Analysis and post processing of the results.

Suggested Reading:

1. R.D. Cook, "Concepts and Application of Finite Element Analysis", John Wiley and Sons, 1981.
2. O.C. Zienkiewicz and R.L. Taylor, "The Finite Element Method, Volume 1: The Basis", McGraw-Hill, London, 1989.J.N. Reddy, "An Introduction to the Finite Element Method", McGraw-Hill, New York, 1993.
3. David V. Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw-Hill, New Delhi, 2005.

4. K.J. Bathe, “Finite Element Procedures”, Prentice Hall of India, New Delhi, 2006.
5. T.R. Chandrupatla and A.D. Belegundu, “Introduction to Finite Elements in Engineering”, Prentice Hall of India, New Delhi, 2001.
6. P. Seshu, “Finite Element Analysis”, Prentice Hall of India, New Delhi, 2003.

CE 1422 *w.e.f. 2017-2018*

RURAL ROADS

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessionals	30 Marks

Course Objectives:

- Introduction to various factors affecting road alignment and planning
- Introduction to inputs required for pavement design
- Concepts of mechanistic empirical methods of flexible and rigid pavements

Course Outcomes:

- Application of basic principles in pavement design for rural roads
- Assimilation of mechanistic principles for the pavement design
- Explain about appropriate quality control measures during construction and evaluation and maintenance measures

UNIT - I

Planning and Alignment: Planning of Rural roads, concept of network planning, rural road plan, road alignment and surveys. Governing factors in route selection, factors considered for alignment.

UNIT - II

Materials and Pavement Design: Introduction, Soil material surveys, embankment and subgrade materials, stabilized soils, road aggregates, aggregate for base courses, new materials as stabilizers, materials for desert areas, materials for bituminous constructions and surfacing;

Materials for rigid pavements, special pavement, climatic suitability of concrete mateiial. Introduction, Design procedure, pavement components, design of flexible and rigid pavements, Special pavements design. Types of drainage, General criteria for road drainage, system of drainage, surface and subsurface systems.

UNIT- III

Construction and Specifications: Introduction, Selection of materials and Methodology, Embankment and subgrade, sub-base (granular), base (granular), shoulder, Bituminous concrete, Semi-rigid pavements construction, and Concrete pavements. Construction of special pavements, Equipment required for different procedures.

UNIT - IV

Waste Materials for Pavement Construction: Introduction, Fly ash for road construction, Design & Construction of Fly ash embankments, Lime fly ash stabilized soil. Lime fly ash bound Macadam, Lime fly ash concrete, rolled compacted fly ash pavements. Control of compaction, concrete stabilized fly ash with admixtures.

UNIT - V

Quality Control in Construction and maintenance: Introduction, Pre requirements, organizational setup, specification and code of practice, Laboratory equipment. Earth and Granular layers, bituminous courses, Semi rigid and rigid pavements, special requirements, recovered of quality control data. Distresses/Defects in rigid and flexible pavements, Maintenance and Evaluation, Inventory of roads and inspections, Types of maintenance activities. Maintenance.

Suggested Reading:

1. IRC manual for rural roads. Special Publication -20 (2002).
2. HMSO, Soil Mechanics for Road-Engineers, London
3. IRC related code books
4. NRRDA -Guidelines and code books

CE 0111 *w.e.f. 2017-2018*

ENGINEERING RESEARCH METHODOLOGY

Instruction	**3 Periods per week**
Duration of University Examination	**3 Hours**
Semester End Evaluation	**70 Marks**
Continuous Internal Evaluation	**30 Marks**
No. of Credits	**3 Credits**

Course Objectives:

- Learn the research types, methodology and formulation.
- Know the sources of literature, survey, review and quality journals.
- Understand the research design for collection of research data.
- Understand the research data analysis, writing of research report and grant proposal.

Course Outcomes:

- Differentiate the research types and methodology.
- Able to do literature survey using quality journals.
- Able to collect research data.
- Process research data to write research report for grant proposal.

UNIT - I

Research methodology: Objectives and motivation of research - Types of research - Research approaches - Significance of research - Research methods verses methodology - Research and scientific method - Importance of research methodology - Research process - Criteria of good research - Problems encountered by researchers in India - Benefits to the society in general. Defining the research problem: Definition of research problem - Problem formulation - Necessity of defining the problem - Technique involved in defining a problem.

UNIT – II

Literature survey: Importance of literature survey - Sources of information - Assessment of quality of journals and articles - Information through internet. Literature review: Need of review - Guidelines for review - Record of research review.

UNIT – III

Research design: Meaning of research design - Need of research design - Feature of a good design - Important concepts related to research design - Different research designs - Basic principles of experimental design - Developing a research plan - Design of experimental set-up - Use of standards and codes.

UNIT – IV

Data collection: Collection of primary data - Secondary data - Data organization - Methods of data grouping - Diagrammatic representation of data - Graphic representation of data - Sample design - Need for sampling - Some important sampling definitions - Estimation of population - Role of statistics for data analysis - Parametric vs. non parametric methods - Descriptive statistics - Measures of central tendency and dispersion - Hypothesis testing - Use of statistical softwares.

Data Analysis: Deterministic and random data - Uncertainty analysis - Tests for significance - Chi-square - Student's t-test - Regression modeling - Direct and interaction effects – ANOVA - F-test - Time series analysis - Autocorrelation and autoregressive modeling.

UNIT - V

Research report writing: Format of the research report – Synopsis – Dissertation - Thesis - Its differentiation – References – Bibliography – Webliography - Technical paper writing - Journal report writing - Making presentation - Use of visual aids.

Research proposal preparation: Writing a research proposal and research report - Writing research grant proposal.

Suggested Reading:

1. C.R Kothari, "Research Methodology, Methods & Technique", New Age International Publishers, New Delhi, 2004.
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, Chennai, 2011.
3. Ratan Khananabis and Suvasis Saha, "Research Methodology", Universities Press, Hyderabad, 2015.
4. Y.P. Agarwal, "Statistical Methods: Concepts, Application and Computation", Sterling Publishing Pvt. Ltd., New Delhi, 2004.
5. Vijay Upagade and Aravind Shende, "Research Methodology", S. Chand & Company Ltd., New Delhi, 2009.
6. G. Nageswara Rao, "Research Methodology and Quantitative methods", BS Publications, Hyderabad, 2012.

CE 1431 *w.e.f. 2017-2018*

TRAFFIC DESIGN AND STUDIO

Instruction	**3 Periods per week**
Internal Assessment	**50 Marks**
No. of Credits	**2 Credits**

Course Objectives:

- To understand the basic parameters of driver behavior components
- To understand the basic parameters to be obtained from various types of traffic surveys
- To impart knowledge parameters of parking needs and accident causes

Course Outcomes:

- To conduct traffic surveys, analyse and prepare summary/design reports related to intersection/road stretch improvements
- To design signals
- To investigate parking demand and to conduct accident analysis

1. Driver testing Experiments

2. Intersection designs

3. Signal Design

4. Speed and Delay Studies

5. Origin and Destination Studies

6. Travel Behaviour Studies

7. Traffic Simulation

8. Cellular Automata applications

9. Parking Studies

10. Accident Studies

Note: All the Data Collection procedures As per HCM 2000

CE 1432 *w.e.f. 2017-2018*

HIGHWAY MATERIALS & PAVEMENT ENGINEERING LAB

Instruction	**3 Periods per week**
Internal Assessment	**50 Marks**
No. of Credits	**2 Credits**

Course Objectives:

- To conduct various standard tests on aggregate and bitumen
- To understand the properties of bituminous mixes

Course Outcomes:

- Characterise the pavement materials.
- Perform quality control tests on pavement material and pavements.

1. Aggregate Tests

2. Bitumen and Tar Tests as per IS code provisions

3. Benkelman beam test

4. Stone Polishing Value test

5. International Roughness Index test

6. Mix design for Bituminous mixes

7. California Bearing Ratio Test

8. Soil Classification & Grain size analysis .

9. Rolling Dynamic Deflectometer

10. Falling Weight Deflectometer

Note: All tests as per IS, ASTM, AASHTO, TRL, IRC procedures/specifications and guidelines

CE 1433 *w.e.f. 2017-2018*

SEMINAR - I

Instruction	**3 Periods per week**
Internal Assessment	**50 Marks**
No. of Credits	**2 Credits**

Course Objectives:

- Prepare the student for a systematic and independent study
- Selection of topics in the state of art topics in his/her specialization

Course Outcomes:

- Literature collection and broad understanding of the concepts of domain area
- Effective preparation and presentation skills.

A student is expected to take-up an actual case study pertaining to a alive. Transportation project and attend the site three times a week to note the development and implementation of project. The student shall interact with the seminar supervisor during the instruction period and prepare weekly report. At the end of semester, the candidate shall present a seminar on the project.

CE 1434 *w.e.f. 2017-2018*

SEMINAR II

Instruction	**3 Periods per week**
Internal Assessment	**50 Marks**
No. of Credits	**2 Credits**

Course Objectives:

- Problem definition
- Literature survey, familiarity with research journals
- Broad knowledge of the available techniques to solve the problem
- Technical writing skills
- Presentation skills

Course Outcomes:

- Selection of focused area for dissertation work.
- Understanding the methodology and enhancing presentation skills

A student is expected to take-up an actual case study pertaining to a live Transportation project and attend the site three times a week to note the development and implementation of project. The student shall interact with the seminar supervisor during the instruction period and prepare weekly report. At the end of the semester, the candidate shall present a seminar on the project.

CE 1435 *w.e.f. 2017-2018*

Project Seminar

Instruction	**4 Periods per week**
Sessional:	**100 Marks**
No. of Credits	**8 Credits**

Course Objectives:

- Define the statement of research problem.
- Update the literature in chosen area of research and establish scope of work.
- Develop the study methodology.
- Carryout basic theoretical study/experiment.

Course Outcomes:

- Identify the statement of research problem.
- Conduct the literature review and establish scope of work.
- Comprehend the study methodology.
- Conduct basic theoretical study/experiment.

Each student will be attached to a faculty member, (guide) for Mini Project during the Second Semester. The student will carry out the project which may be the development of Software - Hardware - Simulation Studies - Design - Analysis - Experimental related to the specialization. The work will be monitored regularly by the guide. At the end of the Semester, Student will write the report on the work done and submit to the guide. Student has to present the work before two faculty members (one guide and other to be appointed by Chairman BOS) on a fixed day during the last week of the semester in which mini project is offered. The sessional marks will be awarded jointly by these two examiners based on the report, the presentation and viva voce.

CE 1436 *w.e.f. 2017-2018*

DISSERTATION

Instruction	**6 Periods**
University Examination	**Viva Voice**
Marks	**200**
No. of Credits	**16 Credits**

Course Objectives:

- Expand on the defined research problem in dissertation.
- Conduct laboratory/analytical studies.
- Analyse data, develop models, offer solutions and give conclusions.

Course Outcomes:

- Develop on the defined research problem in dissertation.
- Carry out laboratory/analytical studies.
- Evaluate data, develop models , offer solutions and give conclusions.

Each student will be attached to a faculty member who will monitor the progress of the student. The student is required to submit a technical write-up, presentation of their study (about 20 minutes) followed by a discussion.

The dissertation shall be internally scrutinized by a Viva-Voce committee consisting of the Head of the Department, Chairman Board of Studies, Supervisor and Examiner.

The Dissertation will be scrutinized by an external examiner as per the institute guide lines applicable.

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