With effect from academic year 2021-22

DEPARTMENT OF CIVIL ENGINEERING

Scheme of Instruction

and

Syllabus of

M.E. (CIVIL ENGG)

Specialization: Transportation Engineering

Full Time & PTPG

AICTE Model Curriculum

2021-22

UNIVERSITY COLLEGE OF ENGINEERING

(Autonomous)

Osmania University

Hyderabad – 500 007, TS, INDIA

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. **PEO1**: Apply and enrich technical knowledge in the fields of Highway, Traffic and Transportation Engineering
2. **PEO2**: 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. **PEO3**: Motivate and engage themselves to carryout innovative research in core and multidisciplinary areas and disseminate the same through publications.

4. **PEO4**: Communicate effectively with peers and practice their profession with regard to societal needs, with ethical responsibilities for sustainable development

Programme Outcomes:

PO1	An ability to independently carry out research / investigation and development work to solve practical problems
PO2	An ability to write and present a substantial technical report/document
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor degree.
PO4	Familiar to use and apply the analysis methods / state of the art testing/construction techniques for solving various problems related to Transportation Engineering
PO5	Able to conduct surveys and design of the transportation engineering infrastructure facilities for safe urban transportation systems.

With effect from academic year 2021-22

Scheme & Syllabus for

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

Type of course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
SEMESTER-I								
Core-I	CE401	Pavement Materials Characterization	3			30	70	3
Core-II	CE402	Urban Transportation System Planning	3			30	70	3
Professional Elective-I	CE411	Statistical Techniques	3			30	70	3
	CE412	Behavioural Modelling						
	CE311	Ground Improvement Techniques						
Professional Elective-II	CE413	Traffic Engineering	3			30	70	3
	CE414	Rural and Regional Transportation Systems						
	CE103	Finite Element Techniques						
Audit-I	AC131	Disaster Mitigation and Management	3			30	70	0
	AC031	English for Research Paper Writing						
	AC 033	Sanskrit for Technical Knowledge						
	AC 034	Value Education						
Lab-I	CE451	Traffic Engineering Lab			3	50	-	1.5
Lab-II	CE452	Highway Materials Lab			3	50	-	1.5
MC	CE100	Research Methodology in Civil Engineering	2	1		30	70	3
TOTAL			**17**	**1**	**6**	**280**	**420**	**18**
SEMESTER-II								
Core-III	CE403	Pavement Systems Engineering	3			30	70	3
Core-IV	CE404	Design of Highway Infrastructure	3			30	70	3
Professional Elective-III	CE416	Analysis of Transportation Systems	3			30	70	3
	CE417	Highway Construction and Quality Control						
	CE418	Rural Roads						
Professional Elective-IV	CE419	Economic Evaluation and Analysis of Transportation Projects	3			30	70	3
	CE420	Transportation Modelling& Simulation						
	CE421	Airport Planning & Design						
Audit-II	AC035	Stress Management by Yoga	2	1		30	70	0
	AC036	Personality Development through Life Enhancement Skills						
	AC037	Constitution of India						
	AC 038	Pedagogy Studies						
MC	CE 070	Mini Project			6	50		3
Lab-III	CE453	Pavement Engineering Lab			3	50	-	1.5

Seminar	CE461	Seminar			3	50	-	1.5
TOTAL			**14**	**1**	**12**	**300**	**350**	**18**
SEMESTER-III								
Professional Elective-V	CE422	Pavement Evaluation Maintenance & Management	3			30	70	3
	CE423	Railway Engineering						
	CE119	Bridge Engineering						
Open Elective	OE941	Business Analytics	3			30	70	3
	OE942	Industrial Safety						
	OE943	Operational Research						
	OE944	Cost Management of Engineering Projects						
	OE945	Composite Materials						
	OE946	Waste to Energy						
	OE947	Internet of Things						
	OE948	Cyber Security						
	CE48	Major Project Phase-I	6		20	100		10
TOTAL			**12**		**20**	**160**	**140**	**16**
SEMESTER-IV								
	CE482	Major Project Phase-II			**32**		**200**	**16**
GRAND TOTAL								**68**

CIE : Continuous Internal Evaluation SEE : Semester End Examination

SEMESTER-I

CE 401

PAVEMENT MATERIALS CHARACTERIZATION

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 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:

1. *Understand the index properties and the various tests conducted on subgrade soil and road aggregates*
2. *Understand subgrade soil strength in terms of standard engineering parameters and Choose appropriate stabilization technique by using different admixtures.*
3. *Understand the various tests conducted on bitumen, bituminous mixes and do Bituminous Mix design and determine optimum binder content.*
4. *Understand the various tests conducted on bitumen and mixes as per Superpave Technology.*
5. *Understand the various tests conducted on cement, cement mixes and do cement concrete mix design and apply corrections.*

UNIT – I

Soil and Aggregate: Soil-Classification methods, AASTO Method, USCS, IS Method; Tests on soil: Consistency, Engineering Properties, CBR, and Modulus of sub-grade reaction of soil, selection of suitable filter for soils, Triaxial method and Dynamic Cone Penetrometer (DCP). Aggregate Origin, Classification, requirements, properties and tests on road aggregates used for flexible and rigid pavements. Blending of aggregates, Importance of aggregate shape factor in mix design.

UNIT – II

Methods of Soil Stabilization: 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; Stabilization Methods: mechanical soil stabilization, lime-soil, soil-bituminous, soil-lime-fly ash mixes, soil-cement.

UNIT – III

Bitumen and Bituminous Mix Design; Origin, preparation, Definitions, properties, requirements, criteria for selection of different binders, Types of Bituminous emulsion and Cutbacks, fillers, extenders, polymers, Crum rubber, and rubber modified bitumen and anti-Stripping agents on pavement performance. Blending method of aggregates, Bituminous mix design as per Marshall Mix method, binder content, gradation, Engineering properties: Marshal stability test; example problem, static creep test, Resilient & dynamic modulus test, flexural test, splitting tension test. Introduction to Recycling of bituminous mixes.

UNIT – IV

Introduction to Super pave Technology: Methods of selection of suitable ingredients for super pave method, PG bitumen, 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.

UNIT – V

Cement and Cement concrete mixes: Tests on Cement, Requirements of paving concrete, water cement ratio, grade of concrete, mix design with example problem, moisture-corrections, mineral and chemical admixtures, Role of different admixtures in cement concrete performance and tests on fresh and hardened cement concrete. Methods of recycling, equipment, Introduction to recycling of cement concrete.

References:

1 Paul H. Wright, Karen K. Dixon, *Highway Engineering*, John Wiley & Sons, 7th edition, 2004.
2 Yoder E.J, and Witczak , *Principles of Pavement Design*, M. W. John Wiley & Sons, 1975.
3 Asphalt Institute, *Superpave Mix Design*. Superpave Series No. 2 (SP-02). Asphalt Institute. Lexington, KY, 2001.
4 Srinivasa Kumar R, *Text Book of Highway Engineering*, Universities Press, India, 2014.
5 Related publications/codes of IRC and IS.

CE 402

URBAN TRANSPORTATION SYSTEMS PLANNING

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 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:

1. *Able to apply the planning methodologies*
2. *To identify the appropriate data collection methods and its procedures*
3. *Able to perform travel demand forecasting*
4. *Perform trip distribution and model split analysis*
5. *Perform trip assignment and prepare master plan.*

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.

CE411

STATISTICAL TECHNIQUES
(PROFESSIONAL ELECTIVE – I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 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:*

1. *Use sampling techniques for conducting various surveys related to transportation Engineering*
2. *Apply the statistical distributions to traffic problems*
3. *Decide best fit and develop the regression equations for the given variables*
4. *Apply multi-variant data distributions.*
5. *Applications ofsampling 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 interval 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

CE412

BEHAVIOURAL MODELLING
(PROFESSIONAL ELECTIVE – I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 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:

1. *Apply the methods of model estimation*
2. *To demonstrate the methods of estimation of discrete choice theory and statistics for model estimation*
3. *To explain binary logit model and multinomial logit models including random utility theory*
4. *To identify various aggregate forecasting techniques and comparing with traditional methods*
5. *Apply nested logit model travel demand model*

UNIT -I

Introduction & Review of the statistics of Model Estimation: Background of Discrete Choice-analysis, Transportation applications ofDiscrete 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.

CE 311

GROUND IMPROVEMENT TECHNIQUES
(PROFESSIONAL ELECTIVE – I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 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:

1. *Ability to understand the necessity of ground improvement and evaluation of potential of a ground for improvement*
2. *comprehensive understanding about the improvement of in-situ cohesive soils as well as Cohesion less soils*
3. *Knowledge of Grouting & other soil stabilization methods and competence to apply them for ground improvement*
4. *Ability to understand and implement the Geosynthetic applications*
5. *Competence to analyse an in-situ ground, identification of ground improvement techniques feasible, selection of the ideal method, its implementation and evaluation of improvement level*

UNIT - I

Introduction : Objectives and necessity of Ground Improvement – Formation of Rock and soils – Alteration of ground after its formation – Reclaimed soils – , Types and distribution of Soils in India - marine, black cotton soils (expansive), lateritic, alluvial, desert, peaty Soils etc - Ground improvement potential – Geotechnical processes.

UNIT - II

Surface Compaction methods : Compaction Mechanism - moisture density relationship – Factors affecting compaction – Laboratory evaluation of Compaction Characteristics – Field Surface Compaction Methods – Compaction procedure – Specification – Quality Control aspects.

In-situ Densification of Cohesionless Soils : Necessity for Deep compaction – Vibration methods – Vibro-compaction methods (Blasting, Vibratory probe, Dynamic compaction / heavy tamping), Vibro-displacement Methods (Displacement Piles, Sand Compaction Piles), vibro-replacement cum displacement methods (Vibro-floatation, Stone Columns).

UNIT - III

In-situ Densification of Cohesive Soils:

Drainage methods – Methods of dewatering systems - selection of pumps and accessories

Pre-compression methods – Concept & benefit of pre-compression -consolidation of Clayey soils – Pre-loading technique – consolidation acceleration methods - consolidation aided with

vertical drains – Sand Drains - Pre-fabricated vertical drains, Consolidation by Electro-osmosis and vacuum compression methods - Compression monitoring.

UNIT - IV

Grouting: Aspects of grouting – Types of grout materials – Classification based on Groutability Ratio - grouting procedure – Applications of grouting in ground improvement.

Soil Stabilisation: Types and suitability of stabilization methods - Mechanical, Cementing methods – Aggregants and dispersants – Stabilization procedure – quality control in Soil Stablization.

UNIT - V

Geo-Synthetics: Classification of Geosynthetics – Functions and applications – Concept of design by function.

Reinforced Soil Walls – Components of a RSW – Types of facia – Types of Reinforcement & factors influencing the selection - Design of RSW – construction procedure - Gabions.

Suggested Reading:

1. H.R. Hausmann, (2013), *Principles of Ground Modification*, Mc-Graw Hill Publications.
2. P.Nicholson, (2015), *Soil Improvement and Ground Modification Methods*, Butterworth-Heinemann Ltd.
3. Purushotham Raj, (2016), *Ground Improvement Techniques*, Laxmi Publications.
4. R.M.Koerner, (2012), *Designing with Geosynthetics Vol-1&2*, Prentice Hall Inc.
5. Indrarathna, Chu, Cholachat, (2015), *Ground Improvement Case Histories*, Butterworth-Heinemann Publications.

CE 413

TRAFFIC ENGINEERING
(PROFESSIONAL ELECTIVE – II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *To understand the basic aspects of traffic Engineering.*
- *To describe basic techniques for collecting and analysing traffic data, diagnosing problems.*

Course Outcomes:

Students who successfully complete this course will be able to:

1. *Knowledge on traffic stream characteristics and apply the statistical concepts and applications in traffic engineering.*
2. *Able to conduct traffic studies and Identify traffic problems*
3. *Solve the problems related to travel time and delay.*
4. *Knowledge on traffic capacity and level of service.*
5. *Design a pre-timed traffic signal 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, 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, time 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.

CE414

RURAL AND REGIONAL TRANSPORTATION SYSTEMS
(PROFESSIONAL ELECTIVE – II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 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:

1. *Knowledge on planning and development concepts*
2. *Understand methodology and models for rural transportation system*
3. *Develop population forecasting models*
4. *Perform fright transportation analysis*
5. *Conduct regional transportation case studies*

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.

CE103

FINITE ELEMENT TECHNIQUES
(PROFESSIONAL ELECTIVE – I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 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:

1. *Build and analyse the FEA models for various engineering problems.*
2. *Identify the information requirements and sources for analysis, design and evaluation.*
3. *Use the standard finite element software to solve the structural engineering problems.*
4. *Interpret the results obtained from FEA software, not only in terms of conclusions but also awareness of limitations.*
5. *To solve FEM problems using weight residual techniques*

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.

AC 131

DISASTER MANAGEMENT AND MITIGATION
(AUDIT COURSE – I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Course Objectives:

- *To know the various types of disasters and its effect on structures.*
- *Study the quality assurance and damage assessment of structures*
- *Educate different types of repair, strengthening, rehabilitation and retrofitting techniques.*
- *Description of Flood mitigation, adjustment, and regulation*
- *Knowledge of Hydrological time series analysis*

Course Outcomes:

1. *Understand the fundamentals of disaster and seismic performance of buildings.*
2. *Able to assess the various damages in structure and give assurance of quality of concrete.*
3. *Decide the appropriate repair, strengthening, rehabilitation and technique required for a case study building.*
4. *Ability to critically review and interpret scientific information on mathematics of flood forecasting and flood routing*
5. *Advanced understanding of flood plain adjustment issues and the other technologies employed for flood management.*

UNIT – I

Disaster: Classifications - Causes - Impacts including social, economical, political, environmental, health, psychosocial, etc.
Seismicperformanceofbuildings:casestudiesofmajorearthquakesinthecountry,damagetobuildings, damagepatterns,performanceofnon-engineeredbuildings.
Introduction to Repair and rehabilitation of structures**.**

UNIT – II

Quality assurance for concrete – Strength, Durability and Thermal properties of concrete.
Damage Assessment: Condition assessment and distress, Purpose of assessment, Rapid assessment - diagnostic techniques, Investigation of damage, Evaluation of surface and structural cracks, Damage assessment procedure, destructive, non-destructive and semi destructive testing systems, Procedure for evaluating damaged of structure.

UNIT III

Repair, Rehabilitation And Retrofitting Techniques : Repair materials, Common types of repairs – Repair in concrete structures – Repairs in under water structures – Guniting – Shot create –Underpinning, Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, Leakage, earthquake, Retrofitting techniques.

UNIT - IV

Flood characteristics and forecasting: Measureable features of a flood (Elevation, discharge, volume, and duration), flood forecasting (unit hydrograph method, meteorological and snow data, and snow field air temperatures), operation of flood forecasting systems.

Space-time characteristics of rainfall: Policy criteria for design flood of a major and minor reservoir, spillways, diversion dams and barrages, design flood criteria for dams and other hydraulic structures (CWC recommendations).

UNIT - V

Flood Routing: Mathematics of flood routing, various methods of flood routing, Hydrologic and Hydraulic routing.

Flood mitigation: flood ways, channel improvement, evacuation and flood proofing, land management, flood plain management, estimating benefits of flood mitigation.

Flood plain adjustments and regulations: Results of controlling floods, alternatives to controlling floods, range of possible adjustments, practical range of choice, critical characteristics of flood hazards.

Suggested Reading

1. Barry A. Richardson, "Defects and Deterioration in Buildings", E &FN Spon Press, London, 1991.
2. J. H. Bungey, "Testing of Concrete in Structures", Chapmanand Hall, New York, 1989.
3. A.R. Santakumar, "Concrete Technology", Oxford UniversityPress,New Delhi, 2006.
4. Pankaj Agarwal andManishShrihkande (2006). "EarthquakeResistanceDesignofStructures." Prentic Hall of India

5 Ravishankar.K., Krishnamoorthy.T.S, "Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures", Allied Publishers, 2004. 4.

6. CPWD and Indian Buildings Congress, Hand book on Seismic Retrofit of Buildings, Narosa Publishers, 2008.
7. Ven Te Chow (1964), 'Hand Book of Applied Hydrology', McGraw-Hill Publishers, New York.
8. Linsley, R. K. and Franzini A. W. (1992), 'Water Resource Engineering', McGraw-Hill Publishers, New York
9. Varshney, R. S. (1979), 'Engineering Hydrology', Nem Chand Publishers, Roorkee.
10. Jaya Rami Reddy, P. (1987), 'A. Text Book of Hydrology', Lakshmi Publishers, New Delhi.

AC 031

ENGLISH FOR ACADEMIC AND RESEARCH WRITING
(AUDIT COURSE – I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Course Objectives:

- *features of Academic writing; different kinds of Academic writing*
- *some academic writing skills; the research process; the structure of a research document*

Course Outcomes:

1. *Academic writing features; Academic writing kinds; Important academic writing skills*
2. *The process of research; general research document structure*

UNIT I: Features of Academic Writing

Language: Clear, Correct, Concise, Inclusive; **Tone**: Formal, Objective, Cautious; **Style**: Appropriate, Accurate, Organized; **Ethics**: Honesty, Integrity, Responsibility, Accountability

UNIT II: Kinds of Academic Writing
Essays, Reports, Reviews, Abstracts, Proposals

Unit III: Academic Writing Skills
Paraphrasing; Summarizing; Quoting; Rewriting; Expansion

Unit IV: **Research Process**
Selection of Topic, Formulation of Hypothesis, Collection of Data, Analysis of Data, Interpretation of Data, Presentation of Data

Unit V: Structure of a Research Document
Title, Abstract, Introduction, Literature Survey, Methodology, Discussion, Findings/Results, Conclusion, Documenting Sources (IEEE style)

Suggested Reading:

1. Bailey, S. (2014). *Academic writing: A handbook for international students*. Routledge.
2. Gillett, A., Hammond, A., &Martala, M. (2009). *Inside track: Successful academic writing*. Essex: Pearson Education Limited.
3. Griffin, G. (2006). *Research methods for English studies*. Edinburgh: Edinburgh University Press. Silyn-Roberts, Heather. (2013). Writing for Science and Engineering: Papers, Presentations and Reports(2nd ed.). Elsevier.
4. Lipson, Charles (2011). *Cite right: A quick guide to citation styles; MLA,APA, Chicago, the sciences, professions, and more* (2nd ed.). Chicago[u.a.]: University of Chicago Press.

CE451

TRAFFIC ENGINEERING LAB

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Course Objectives:

- *To conduct various traffic surveys*
- *To understand fundamental principles of traffic engineering by conducting surveys*

Course Outcomes:

1. *Understand and apply the principles of Traffic Engineering*
2. *Able to conduct traffic surveys and analyze the data*
3. *Preparing the technical report and presenting the seminar in domain area to disseminate knowledge among professional peers.*

1. Introduction to traffic engineering and the surveys
2 Traffic volume count survey
3. Spot speed survey
4. Speed and delay study by moving observer method
5. Speed and delay study at signalised intersection
6. Traffic flow directional distribution survey at intersection
6. Traffic Signal design by Webster's method
7. Parking surveys

Note: All tests as per IRC guidelines

CE452

HIGHWAY MATERIALS LAB

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Course Objectives:

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

Course Outcomes:

1. *Characterize the pavement materials.*
2. *Perform quality control tests on pavement material and pavements*
3. *Bituminous mix design*

1. Aggregate Tests
2. Bitumen and Tar Tests as per IS code provisions
3. Stone Polishing Value test
4. Mix design for Bituminous mixes
5. California Bearing Ratio Test
6. Soil Classification & Grain size analysis .

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

CE 100

RESEARCH METHODOLOGY IN CIVIL ENGG.

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

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:

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

UNIT – I

Scientific Research: Definition, Characteristics, Types, Need of research. Research methods vs Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.
Defining and formulating the research problem-Meaning of a research problem, Sources of research problems, Criteria of a good research problem, Importance of literature review in defining a problem, Errors in selecting a research problem, Scope and objectives of the research problem. Approaches of investigation of solutions for the research problem.

UNIT – II

Literature review-Source of literature, Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.
Research design – Basic Principles, Need of research design, Features of good design, Important concepts relating to research design.
Developing a research plan - Exploration, Description, Diagnosis, Experimentation. Determining experimental and sample designs.

UNIT – III

Execution of the research - Necessary instrumentations, Various data collection methods in Civil Engineering. Data processing and data interpretation. Data presentation and illustration.
Types of the reports–Technical reports and thesis; Different steps in the preparation – Layout, structure and language of technical writing; Writing research papers; Developing a Research Proposal, Common formats of the research proposals; Oral presentation–Planning, Preparation, Practice, Making a presentation, Importance of effective communication

UNIT – IV

Ethical issues - Research ethics, Plagiarism, Citation and acknowledgement
Patenting and development: technological research, innovation, patenting, and development. International Scenario: International cooperation on Intellectual Property. Procedure for

grants of patents, Patenting under PCT Patent Rights. Problems encountered by researchers in India.

UNIT – V

Basics of statistics. Sampling and its types. Determination of sampling size. Sampling and non-sampling errors in statistics. Data: handling of data-significant figures & rounding. quality of data- precision & accuracy. Types of data.

Descriptive statistics: Summarization of Data- Measure of central tendency, Measure of central dispersion, Measure of symmetry.

Inferential statistics: Hypothesis of testing, Parametric (t-test & Analysis of variance) and Non-Parametric Tests. Univariate and Bivariate analysis; Correlational analysis. Introduction to linear regression model and multi-linear regression models. mathematical basis and introduction to SPSS

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 SuvasisSaha, "Research Methodology", Universities Press, Hyderabad, 2015.
4. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & Engineering students"
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
6. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008
8. Y.P. Agarwal, "Statistical Methods: Concepts, Application and Computation", Sterling Publishing Pvt. Ltd., New Delhi, 2004.
9. Vijay Upagade and Aravind Shende, "Research Methodology", S. Chand & Company Ltd., New Delhi, 2009.
10. G. Nageswara Rao, "Research Methodology and Quantitative methods", BS Publications, Hyderabad, 2012.

SEMESTER-II

CE403

PAVEMENT SYSTEMS ENGINEERING

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Introduction to various factors affecting pavements design*
- *Analysis of stresses in flexible and rigid pavements*
- *Concepts of mechanistic empirical methods of flexible and rigid pavements*

Course Outcomes:

1. *Application of basic principles in pavement design and analyze the inputs for pavement design*
2. *Analyze stresses in flexible pavement*
3. *Analyze stresses in rigid pavement and dowel bars*
4. *Design of flexible pavement including filter and drainage layers*
5. *Design of rigid pavement including dowels and tie bars*

UNIT – I

Introduction to Pavement Design: Types of Pavements, Functions of pavement, types of pavements and functions of their individual Layers, Factors affecting pavement selection,Various Factors affecting pavement design, Traffic factors, Climatic factors, Classification of Axle Types and Articulated Commercial Vehicles, Standard Axle load, Legal Axle and Gross weights on single and multi units, Methods of measurement of Axle Load and Truck Weight , Tire Pressure, Contact pressure, ESAL concepts, Fourth power rule, factors affecting VDF, Traffic Analysis: ESAL, VDF, 98the percentile axle load, lane distribution, Directional distributions, Effect of Transient & Moving loads.

UNIT – II

Stresses in Flexible Pavement: Vehicle-Pavement Interaction, Stress inducing factors in flexible pavement, Stress in Flexible Pavements: Visco-Elastic Theory and Assumptions. Layered system concepts, Stresses in one and two and Linear Elastic Multi-layered Pavement System. Boussinsq theory and assumptions. Burmister Theory and assumptions. Overview on Softwares used for stress analysis.

UNIT – III

Stresses in Rigid Pavement: Stresses in Rigid Pavements: Westergaard's theory and Assumptions, Stresses due loading, warping and Frictional Stresses, critical locations of wheel loads on a rigid pavement, Equivalent circular contact area considered for rigid pavement design, Influence of Temperature and moisture, Critical Combined stress Due to Warping and load, Critical combination of stresses in India, Friberg's Analysis of Dowel Bars and deflection of dowels at joints. Overview on software/charts for analysis of rigid pavements

UNIT – IV

Design of Flexible pavement: Empirical Methods and their limitations, overview on Pure Mechanistic Method,Mechanistic Design Methodology for Pavements: General Methodology, Classification of design methods; Benefits of Pavement Design Based on M–E Method ,Pavement Design Concepts; Flexible Pavement Design Concepts, IRC Method as per IRC37-2018, Salient features of IRC:37-2018, Sub-surface drainage considerations and design of drainage and filter layers, Design Criteria, IRC specifications.

UNIT – V

Design of Rigid Pavements: Types of Rigid Pavements , Pavement Joints, Introduction to Mechanistic Design Process, main factors are considered for the design of rigid pavements, Top down cracking (TDC) and bottom up cracking (BUC), Critical location of placement of first rear axle considered for determination of max. edge flexural stress for BUC case and max.tensile stress for TDC case. Design Criteria, IRC specifications, Dowel bar design and design of tie bars as per IRC:58-2015.

References:

1 Yang H. Huang, *Pavement Analysis & Design*, Prentice Hall Inc.
2 Yoder J. &Witzac, *Principles of Pavement Design*, John Wiley & Sons
3 Srinivasa Kumar R, *Transportation Engineering*, Universities Press, 2019
4 Srinivasa Kumar R, *Pavement Design*, Universities Press, 2012
5 IRC:58-2015, IRC:37-2018 and Other relevant IRC Codes

CE404

DESIGN OF HIGHWAY INFRASTRUCTURE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 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:

1. *Understand the concepts and applications of the elements involved in Highway Geometric Design.*
2. *Able to design Horizontal and Vertical Curves*
3. *Apply the principles of Intersection design.*
4. *Knowledge on Traffic signs and Road markings*
5. *Able to understand pedestrian elements, 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.

CE416

ANALYSIS OF TRANSPORTATION SYSTEMS
(PROFESSIONAL ELECTIVE - III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 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:

1. *To describe and evaluate various transportation systems impacts on society and economy*
2. *To identify the different solutions for linear programming problems including sensitivity analysis.*
3. *To demonstrate effective way of understanding transportation and assignment problems*
4. *Able to analyse network flows.*
5. *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.

CE417

HIGHWAY CONSTRUCTION AND QUALITY CONTROL
(PROFESSIONAL ELECTIVE - III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 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:

1. *Students who successfully complete this course will be able to:*
2. *Plan and control construction related activities.*
3. *Gain knowledge about different methods and techniques of base, sub base and drainage construction.*
4. *Understand bituminous pavement construction procedure*
5. *Understand cement concrete pavement construction procedure*
6. *Able 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, PeurifoyR.C,andC.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.

CE418

RURAL ROADS
(PROFESSIONAL ELECTIVE - III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Introduction to various factors affecting road alignment and planning*
- *Introduction to inputs required and design of flexible and pavements*
- *Concepts, equipment and procedures applicable for construction and maintenance of rural roads.*

Course Outcomes:

1. *Acquaintance with development of rural road network in India and learn to conduct alignment surveys*
2. *Application of basic principles in design of flexible pavement rural roads with different combination of layer compositions*
3. *Ability to analyze stresses in concrete pavement and application of basic principles in design of cement concrete pavements used for rural roads*
4. *Comprehensive understanding regarding the rural roads construction using different equipment and materials*
5. *Learn about use of waste materials in road construction and ability to apply knowledge to take up appropriate maintenance measures.*

UNIT – I

Planning and Alignment: The Jayakar Committee, Initial Major Road Development Plans in India, Classification of Roads, Overview on Road Network in India, National Rural Roads Development Agency, PMGSY, Bharath Nirman, DRRP, Core Network. Planning of Rural roads, road alignment and surveys. Governing factors in route selection, factors considered for alignment; Reconnaissance Survey; Preliminary Surveys, Final Location Survey; Details of scales applicable for drawings.

UNIT – II

Guidelines and Design of Flexible Pavements: Introduction, Factors governing design, Calculation of traffic data, Salient features of DCP, Design procedure, pavement components, design of flexible pavement as per IRC:SP:72-2014: Design of Gravel/Soil-Aggregate Roads, Design of pavements for traffic over 100,000 cumulative ESAL and Recommended Pavement Designs. Types of drainage, General criteria for road drainage and shoulders, system of drainage, surface and subsurface systems.

UNIT – III

Guidelines and Design of Cement Concrete Pavements: Factors governing design, Calculation of traffic data, pavement components, Design of Slab thickness as per IRC:SP:62-2014, Sub-base types, calculation of stresses: Computation of equivalent radius of contact area of a dual-wheel, load stresses, temperature stresses, Recommended design procedure; Joints: Types of Joints and their details, Material used and specifications as per MORD.

UNIT – IV

Equipments used for road construction, Construction details of Subgrade, Sub-base and base courses: GSB, WBM, WMM, Quality Control in Construction

Construction steps of of bituminous pavements as per IRC:SP:72 and MORD specifications: Properties of Fly ash, aggregates, soil, sand, bitumen, emulsions, foamed bitumen and other locally available materials, Quality Control in Construction

Construction steps of concrete pavements as per IRC:SP:62 and MORD specifications: Properties of Fly ash, aggregates, soil, cement, sand and other locally available materials, Quality Control in Construction

UNIT – V

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 as per IRC:SP:58, Control of compaction (IS:2720-27), Construction steps.

Maintenance: Introduction, specification and code of practices. Earth and Granular layers, bituminous courses, Semi rigid and rigid pavements, special requirements. Distresses/Defects in rigid and flexible pavements, Maintenance and Evaluation, Inventory of roads and inspections, Types of maintenance activities. Treatment options.

References:

1 Specifications for Rural Roads, First Revision, Published by IRC, New Delhi, 2014. and Training Manuals and Guidelines available at http://pmgsy.nic.in/

2 Quality Assurance Handbook for Rural Roads, Volume-I and Volume-II, NRRDA, MORD, 2007.

3 IRC:SP-20, 2002, IRC:SP72 and IRC:SP:62, IRC:SP:58 and other related code of IRC

4 Construction of Rural Roads, Learning Unit 2.2.1, Published by International Labor Organization, New Delhi, https://rural.nic.in/sites/default/files/2.2.1Roads_English.pdf

5 Srinivasa Kumar R, Text Book of Highway Engineering, Universities Press, 2014.

CE419

ECONOMIC EVALUATION AND ANALYSIS OF TRANSPORTATION PROJECT (PROFESSIONAL ELECTIVE - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *Provide knowledge in project formulation and project development*
- *To understand the principles and methods of economic analysis*
- *Study the Transportation related Environmental Impacts*

Outcomes:

1. *Students who successfully complete this course will be able to:*
2. *Formulate and prepare Detailed Project Report for a highway project.*
3. *Able to estimate Road user costs*
4. *Apply the methods of economic analysis for highway projects.*
5. *Knowledge on Capital financing, Economic Analysis of BOT and BOOT projects*
6. *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

CE420

TRANSPORTATION MODELLING AND SIMULATION
(PROFESSIONAL ELECTIVE - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 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:

1. *Understand the concepts related to modeling*
2. *Understand the classification of models*
3. *Able to perform preliminary data processing*
4. *Build models for transportation simulation*
5. *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

CE421

AIRPORT PLANNING AND DESIGN
(PROFESSIONAL ELECTIVE - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

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

Course Outcomes:

1. *Understand the concepts related to airport planning*
2. *Understand the design elements related to runway design and perform capacity analysis.*
3. *Conduct surveys, develop and design new airports with ICAO/FAA geometric standards*
4. *Able to perform air travel demand analysis*
5. *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. JohnWiley& Sons, New York.
4. Relevant IRC codes.
5. Air Port Engineering, Norman Ashford and Paul H Wright, M.W.JohnWHey& Sons.
6. The Planning and Design of Airports, Robert Horojeff, McGrawHill Book Co..
7. Airport Planning and Design, S.K. Khanna, Arora and S.S. Jain,Nem Chand & Bros. Roorkee.

AC035

STRESS MANAGEMENT BY YOGA
(AUDIT COURSE - II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Course Objectives:

- *Creating awareness about different types of stress and the role of yoga in the management of stress.*
- *Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).*
- *Prevention of stress related health problems by yoga practice.*

Course Outcomes:

1. *To understand yoga and its benefits.*
2. *Enhance Physical strength and flexibility.*
3. *Learn to relax and focus.*
4. *Relieve physical and mental tension through asanas*
5. *Improve work performance and efficiency.*

UNIT-I

Meaning and definition of Yoga - Historical perspective of Yoga - Principles ofAstanga Yoga by Patanjali.

UNIT–II

Meaning and definition of Stress - Types of stress - Eustress and Distress.Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT-III

Concept of Stress according to Yoga - Stress assessment methods - Role ofAsana, Pranayama and Meditation in the management of stress.

UNIT-IV

Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.

UNIT-V

Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama - Kapalabhati Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.
Meditation techniques: Om Meditation - Cyclic meditation : Instant Relaxationtechnique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

Suggested Reading:

1. "Yogic Asanas for Group Training - Part-I": Janardhan Swami Yogabhyasi Mandal, Nagpur.
2. "Rajayoga or Conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.
3. Nagendra H.R nadNagaratna R, "Yoga Perspective in Stress Management", Bangalore, Swami Vivekananda Yoga Prakashan

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc16_ge04/preview
2. https://freevideolectures.com/course/3539/indian-philosophy/11

AC036

PERSONALITY DEVELOPMENT THROUGH LIFE ENHANCEMENT SKILLS (AUDIT COURSE - II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Course Objectives:

- *To learn to achieve the highest goal happily.*
- *To become a person with stable mind, pleasing personality and determination.*
- *To awaken wisdom among themselves.*

Course Outcomes:

1. *Develop their personality and achieve their highest goal of life.*
2. *Lead the nation and mankind to peace and prosperity.*
3. *To practice emotional self regulation.*
4. *Develop a positive approach to work and duties.*
5. *Develop a versatile personality.*

UNIT-I

Neetisatakam – Holistic development of personality - Verses 19, 20, 21, 22(Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

UNIT-II

Neetisatakam – Holistic development of personality (cont'd) - Verses 52, 53, 59(dont's) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

UNIT-III

Introduction to Bhagavadgeetha for Personality Development - Shrimad Bhagawad Geeta: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 – Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

UNIT-IV

Statements of basic knowledge - Shrimad BhagawadGeeta: Chapter 2- Verses56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

UNIT-V

Role of Bahgavadgeeta in the present scenario - Chapter 2 – Verses 17 – Chapter3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38,

Suggested Reading:

1. "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi

Web Resource:

- NTPEL:http://nptel.ac.in/downloads/109104115

AC037

CONSTITUTION OF INDIA
(AUDIT COURSE - II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Course Objectives:

- *The history of Indian Constitution and its role in the Indian democracy.*
- *Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.*
- *Have knowledge of the various Organs of Governance and Local Administration.*

Course Outcomes:

1. *Understand the making of the Indian Constitution and its features.*
2. *Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.*
3. *Have an insight into various Organs of Governance - composition and functions.*
4. *Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.*
5. *Understand Electoral Process, special provisions.*

UNIT-I

History of making of the Indian constitutions: History, Drafting Committee(Composition & Working).
Philosophy of the Indian Constitution: Preamble, Salient Features.

UNIT-II

Contours of Constitutional Rights and Duties Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT-III

Organs of Governance: Parliament: Composition, Qualifications, Powers and Functions, Union executives : President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions

UNIT-IV

Local Administration - District's Administration head: Role and importance. Municipalities: Introduction, ayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati Raj: Introduction, PRI: Zilla Panchayat, Elected Officials and their roles, CEO Zilla Panchayat: positions and role. Block level: Organizational Hierarchy (Different departments) Village level: role of elected and appointed officials. Importance of grass root democracy.

UNIT-V

Election commission: Election Commission: Role and functioning, Chief Election Commissioner and Election Commissioners, State Election Commission :Role and functioning. Institute and Bodies for the welfare of SC/ST/OBC and women**.**

Suggested Reading:

1. "The Constitution of India", 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, "Framing of Indian Constitution", 1st Edition, 2015.
3. M. P. Jain, "Indian Constitution Law", 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.

Web Resource:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

CE 070

MINI PROJECT

Instruction: 6 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 3

Course Objectives:

- *Identify engineering problems in multidisciplinary area reviewing available literature*
- *to formulate a real time problem*

Course Outcomes:

1. *Identify a topic in advanced areas of Transportation Engineering and Literature Review*
2. *Identify gaps and define objectives & scope of the work*
3. *Employ the ideas from literature and develop research methodology*
4. *Develop a model, experimental set-up and / or computational techniques necessary to meet the objectives.*
5. *Report Writing, and presentation skills*

Syllabus Content:

Mini Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available. End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution. Continuous assessment of Mini Project at Mid Semester and End Semester will be monitored by the departmental committee.

CE453

PAVEMENT ENGINEERING LAB

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Course Objectives:

- *To Characterize the pavement materials*
- *To conduct various standard pavement evaluation tests on pavements*
- *To design overlays*

Course Outcomes:

1. *Characterize pavement materials & bituminous mix design*
2. *Evaluate different types of pavement.*
3. *Measure the structural response characteristics of in-service pavements &Overlay design*

1. Field Density
2. Bitumen Content
3. Pavement Condition Rating unevenness using MERLIN
4. Field Evaluation by Dynamic Cone Penetrometer
5. Overlay design using Benkelman beam
6. Falling Weight Deflectometer studies(demo)
7. Field Visits

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

CE 461

SEMINAR

Instruction: 3 periods per week *Duration of SEE: -- hours*
CIE: 50 marks *SEE: -- marks*
Credits: 1.5

Course Objectives:

- *Identify appropriate topic of relevance.*
- *Update literature on technical articles of selected topic and develop comprehension.*
- *Prepare a technical report.*
- *Deliver presentation on specified technical topic.*

Course Outcomes:

1. *Identify a topic in advanced areas of Transportation Engineering and Literature Review*
2. *Identify gaps and define objectives & scope of the work*
3. *Employ the ideas from literature and develop research methodology*
4. *Develop a model, experimental set-up and / or computational techniques necessary to meet the objectives.*
5. *Report Writing, and presentation skills*

At least two faculty members will be associated with the seminar presentation to evaluate and award marks.

SEMESTER-III

CE422

PAVEMENT EVALUATION, MAINTENANCE ANDMANAGEMENT (PROFESSIONAL ELECTIVE – V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

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

Course Outcomes:

1. *Apply and acquainted with the fundamental principles of Pavement and understand functional evaluate by using different equipment*
2. *Awareness about various NDT equipment used for structural pavement evaluation of flexible and rigid pavements*
3. *Evaluating the distress condition of pavements through surface condition surveys and learn possible alternative treatments*
4. *Understanding the basic components of pavement management systems and Capacity to perform and apply LCCA to optimize funding expenditures*
5. *Understand the maintenance needs and propensity for application of knowledge towards of flexible and rigid pavements by using different type of layers.*

UNIT – I

Introduction to Pavement Inventories and Functional Evaluation: Purposes, Classification of pavement evaluation, Basic concept of pavement evaluation and management; functional Evaluation: AASHTO Serviceability concept, International Road Roughness Experiment, Methods of Measuring Roughness: World Bank Roughness Measurement Systems, Response type & Profile type; IRI: Quarter Car Model, Classification of equipment used for Measurement : MERLIN, Bump Integrator, Dipstick and High speed laser-profiler. 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.

UNIT – II

Structural Evaluation: Purpose, Destructive Structural Evaluation, Non-destructive structural evaluation, Pavement Deflection: Different Methods of NDT(Working Principles): Benkelman Beam and limitations of BB, LaCroix Deflectometer, Dynaflect, Road Ratar, Rolling Dynamic Deflectometer, Loadman, Different Types of Falling Weight Deflectometers (FWD) for evaluation of rigid and flexible pavements; Working principle of Geophone, Factors influencing deflections. Overlay design as per IRC:81; Back-calculation of Pavement Layer Moduli and detection of loss of bonding of cement concrete pavements using FWD data.

UNIT – III

Distress/failures Surveys: Distress, definitions, significance of distress measurement,

Categorisation of distresses in asphalt pavement: identification, causes and measurement of distresses of Bituminous and Concrete pavements; Visual Rating and severity levels; symbols of distresses observed,PSI, PCI, Distress modes; Distresses and the possible options of repairs to treat distortion, deformation, deterioration disintegration of bituminous and concrete pavements.

UNIT – IV

Pavement Maintenance Management: Purpose of PMS, Uses of PMS, Basic terminology used in PMS, Components of PMS and related activities, Major steps in implementing PMS -Network and project level analysis, Pavement performance prediction models , Budgeting; Prioritization Techniques; Feedback system, Pavement Preservation, Decision tree, Methods of Priority Ranking, Basic approaches of PMS, Pavement Life Cycle Cost Analysis (LCCA): Cost Components, Basic steps in LCCA, Solution of LCCA – with typical Components involved.

UNIT – V

Highway Maintenance and Treatments: Need of Highway maintenance, Types of maintenance for flexible and rigid pavement layers; WBM, WMM, Bituminous and Cement Concrete pavements; Surface texturing practices, Details of overlay and seal coats: Slurry seal (IRC:SP:81), Open Graded Friction Course, Fibre-stabilized Stone Matrix Asphalt (IRC:SP:79), Micro surfacing, Surface dressing, Semi-Dense Bituminous Concrete, Dense Bituminous Concrete and Bituminous Concrete.

References:

1. Haas and Hudson W.R. *Pavement Management Systems* - McGraw Hill publications
2. Srinivasa Kumar R, *Pavement Evaluation Maintenance and Management*, Universities Press, 2014.
3. *Hand Book of Highway Engineering,*RoberF.Baker, Editor, L.G Byrd D.GraritMikle, Associate Edotor, Van Nostrand Reinhold Comp, 1.975
4. Shahin M.Y. 1994 - Pavement Management for airports, roads and parking lots, 1994.
5. Relevant IRC/Morth Codes and manuals.

CE423

RAILWAY ENGINEERING
(PROFESSIONAL ELECTIVE – V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 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:

1. *Understand general features of railways*
2. *Understand the concepts related to rails, sleepers, track and track stresses*
3. *Develop and design of railway tracks with geometric standards*
4. *Understand the concepts related to sub grade, formation and ballast*
5. *Understand the concepts related to 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.andAgarwal.M.M. "Railway Engineering". Oxford University Press, New Delhi, 2007.
2. Rangwala, K. S. "Principles of Railway Engineering". Charotar publishing House, India (1991)

CE119

BRIDGE ENGINEERING
(PROFESSIONAL ELECTIVE – V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Learn the hydraulic, geological and geo-technical aspects in bridge design.*
- *Analyse, design and detail the bridge deck and box girder systems, steel and composite bridges.*
- *Analyse and design the sub-structures, bridge bearings and various long span bridges.*

Course Outcomes:

After completing the course, the students will able to

1. *Understand the fundamentals and codes of practice of bridge design.*
2. *Design the bridge deck and box girder systems using appropriate method.*
3. *Devise the steel truss and composite steel-concrete bridges.*
4. *Propose the sub-structure components such as pier, abutments, etc. and bridge bearings.*
5. *Design the various types of long span bridges, curved and skew bridges.*

UNIT –I

Introduction:

Types of bridges, materials of construction, codes of practice (Railway and Highway Bridges), aesthetics, loading standards (IRC, RDSO, AASHTO), recent developments box girder bridges, historical bridges (in India and overseas). Planning and layout of bridges, hydraulic design, geological and geo-technical considerations; Design aids, computer software, expert systems.

UNIT – II

Concrete Bridges: Bridge deck and approach slabs, Slab design methods, design of bridge deck systems, slab-beam systems (Guyon-Massonet and Hendry Jaeger Methods), box girder systems, analysis and design. Detailing of box girder systems.

UNIT – III

Steel and Composite Bridges: Introduction to composite bridges, Advantages and disadvantages, Orthotropic decks, box girders, composite steel-concrete bridges, analysis and design, truss bridges.

UNIT – IV

Sub-Structure: Piers, columns and towers, analysis and design, shallow and deep foundations, caissons, abutments and retaining walls.

Bridge appurtenances: Expansion joints, design of joints, types and functions of bearings, design of elastomeric bearings, railings, drainage system, lighting.

UNIT – V

Long span bridges: Design principles of continuous box girders, curved and skew bridges, cable stayed and suspension bridges, seismic resistant design, seismic isolation and damping devices. Construction techniques (cast in-situ, prefabricated, incremental launching, free cantilever construction), inspection, maintenance and rehabilitation, current design and construction practices.

Suggested Reading:

1. "Bridge Engineering Handbook", Wai-Fah Chen Lian Duan, CRC Press, USA, 2000.
2. "Design of Highway Bridges", Barker, P.M. and Puckett, J.A., John Wiley & Sons, New York, 1997.
3. "Theory and Design of Bridges", Xanthakos, P.P., John Wiley & Sons, New York, 1994.

OE941

BUSINESS ANALYTICS
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Understanding the basic concepts of business analytics and applications*
- *Study various business analytics methods including predictive, prescriptive and prescriptive analytics*
- *Prepare the students to model business data using various data mining, decision making methods*

Course Outcomes:

1. *To understand the basic concepts of business analytics*
2. *Identify the application of business analytics and use tools to analyze business data*
3. *Become familiar with various metrics, measures used in business analytics*
4. *Illustrate various descriptive, predictive and prescriptive methods and techniques*
5. *Model the business data using various business analytical methods and techniques*

UNIT-I

Introduction to Business Analytics: Introduction to Business Analytics, need and science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DD decision making and future.

UNIT-II

Descriptive Analytics: Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization

UNIT-III

Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient.

UNIT-IV

Decision Trees: CHAID, Classification and Regression tree, splitting criteria, Ensemble and method and random forest. Clustering: Distance and similarity measures used in clustering, Clustering algorithms, K-Means and Hierarchical algorithms, Prescriptive Analytics- Linear Programming(LP) and LP model building.

UNIT-V

Six Sigma: Introduction, introduction, origin, 3-Sigma Vs Six-Sigma process, cost of poor quality, sigma score, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox

Suggested Reading:

1. U Dinesh Kumar, "Data Analytics", Wiley Publications, 1st Edition, 2017
2. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications with SAS", Associate Publishers, 2015
3. S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", 5th Edition, Cengage, 2015

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc18-mg11/preview
2. https://nptel.ac.in/courses/110105089/.

OE942

INDUSTRIAL SAFETY
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Causes for industrial accidents and preventive steps to be taken.*
- *Fundamental concepts of Maintenance Engineering.*
- *About wear and corrosion along with preventive steps to be taken*
- *The basic concepts and importance of fault tracing.*
- *The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry*

Course Outcomes:

1. *Identify the causes for industrial accidents and suggest preventive measures.*
2. *Identify the basic tools and requirements of different maintenance procedures.*
3. *Apply different techniques to reduce and prevent Wear and corrosion in Industry.*
4. *Identify different types of faults present in various equipments like machine tools, ICEngines, boilers etc.*
5. *Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc*

UNIT-I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes, Fire prevention and fire fighting, equipment and methods.

UNIT–II

Fundamentals of Maintenance Engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT–III

Wear and Corrosion and their Prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications of Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side feed lubrication, Ring lubrication, Definition of corrosion, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

UNIT–IV

Fault Tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, any one machine tool, Pump, Air compressor, Internal combustion engine, Boiler, Electrical motors, Types of faults in machine tools and their general causes.

UNIT–V

Periodic and Preventive Maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of Machine tools, Pumps, Air compressors, Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Suggested Reading:

1. H. P. Garg, "Maintenance Engineering", S. Chand and Company
2. Audels, "Pump-hydraulic Compressors", Mcgraw Hill Publication
3. Higgins & Morrow, "Maintenance Engineering Handbook", Da Information Services.
4. Winterkorn, Hans, "Foundation Engineering Handbook", Chapman & Hall London

OE943

OPERATIONAL RESEARCH
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Introduce the concepts of optimization techniques*
- *Formulation of LPP models*
- *Basic concepts of Non-linear programming, Dynamic programming, Game theory are introduced.*

Course Outcomes:

1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.
5. Student should able to apply graph theory, competitive models, and game theory simulations

UNIT- 1

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.

UNIT- 2

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming.

UNIT- 3

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.

UNIT-4

Scheduling and sequencing - single server and multiple server models deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

UNIT- 5

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Suggested Reading:

1. H.A. Taha, Operations Research, An Introduction, PHI,2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi,1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi,2008
4. Hitler Libermann Operations Research: McGraw Hill Pub.2009
5. Pannerselvam, Operations Research: Prentice Hall of India2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India2010.

OE944

COST MANAGEMENT OF ENGINEERING PROJECTS

(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Introduce the concepts of cost management, inventory valuation , decision making*
- *Fundamentals of cost overruns, project execution and technical activities*
- *Introduce the concepts of Quantitative techniques for cost management, Linear Programming, PERT/CPM*

Course Outcomes:

1. *Understanding of strategic cost management process, control of cost and decision making based on the cost of the project.*
2. *Ability to appreciative detailed engineering activities of the project and execution of projects*
3. *Preparation of project report and network diagram*
4. *Able to plan Cost Behavior, Profit Planning, Enterprise Resource Planning, Total Quality Management.*
5. *Applications of various quantitative techniques for cost management*

UNIT-I

Project Management: Introduction to project managements, stakeholders, roles, responsibilities and functional relationships. Principles of project management, objectives and project management system. Project team, organization, roles, responsibilities. Concepts of project planning, monitoring, staffing, scheduling and controlling.

UNIT-II

Project Planning and Scheduling: Introduction for project planning, defining activities and their interdependency, time and resource estimation. Work break down structure. Linear scheduling methods-bar charts, Line of Balance (LOB), their limitations. Principles, definitions of network-based scheduling methods: CPM, PERT. Network representation, network analysis-forward and backward passes.

UNIT-III

Project Monitoring and Cost Analysis: introduction-Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making, Time cost tradeoff-Crashing project schedules, its impact on time on time, cost. Project direct and indirect costs.

UNIT-IV

Resources Management and Costing-Variance Analysis: Planning, Enterprise Resource Planning, Resource scheduling and levelling. Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement

UNIT-V

Budgetary Control:: Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing. Quantitative techniques for cost management: Linear Programming, PERT/CPM, Transportation Assignment problems, Simulation, Learning Curve Theory.

Suggested Reading:

1. Charles T Horngren "Cost Accounting A Managerial Emphasis", Pearson Education; 14 edition (2012),
2. Charles T. Horngren and George Foster, "Advanced Management Accounting" Prentice-Hall; 6th Revised edition (1 February 1987)
3. Robert S Kaplan Anthony A. Atkinson, "Management & Cost Accounting" , Pearson; 2 edition (18 October 1996)
4. K. K Chitkara, "Construction Project Management: Planning, scheduling and controlling", Tata McGraw-Hill Education. (2004).
5. Kumar Neeraj Jha "Construction Project Management Theory and Practice", Pearson Education India; 2 edition (2015)

OE945

COMPOSITE MATERIALS
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Study the concepts of composite construction.*
- *Learn analysis and designs of composite beams, floors, columns and trusses as per the recommendations of IS codes of practice.*
- *Apply the concepts for design of multi-storey composite buildings.*
- *Scope of analysis is restricted to skeletal structures subjected to prescribed dynamic loads.*

Course Outcomes:

1. *Understand the fundamentals of composite construction, and analysis and designs of composite beams.*
2. *Analyse and design the composite floors*
3. *Select suitable materials for composite columns,*
4. *Analyse composite trusses and understand connection details.*
5. *Analyse and design the multi-storey composite buildings*

UNIT–I

Introduction: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT – II

Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT – III

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT–IV

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT – V

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Suggested Reading:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
3. Hand Book of Composite Materials-ed-Lubin.
4. Composite Materials – K.K.Chawla.
5. Composite Materials Science and Applications – Deborah D.L. Chung.
6. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

OE946

WASTE TO ENERGY
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *To know the various forms of waste*
- *To understand the processes of Biomass Pyrolysis.*
- *To learn the technique of Biomass Combustion.*

Course Outcomes:

1. *Understand the concept of conservation of waste*
2. *Identify the different forms of wastage*
3. *Chose the best way for conservation to produce energy from waste*
4. *Explore the ways and means of combustion of biomass*
5. *Develop a healthy environment for the mankind*

UNIT-I

Introduction to Energy from Waste: Classification of waste as fuel – Agrobased,Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT-II

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal –Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT-III

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraftgasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT-IV

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exoticdesigns, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT-V

Biogas: Properties of biogas (Calorific value and composition) - Biogas planttechnology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Suggested Reading:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

OE947

INTERNET OF THINGS
(Open Elective)

Instruction: 3periods per week — Duration of SEE: 3 hours
CIE: 30 marks — SEE: 70 marks
Credits: 3

Course Objectives:

- To understand the concepts of Internet of Things and able to build IoT applications
- To learn the programming and use of Arduino and Raspberry Pi boards.
- To know about data handling and analytics in SDN.

Course Outcomes:

After Completion of the course Student will be able to:

1. Known basic protocols in sensor networks.
2. Program and configure Arduino boards for various designs.
3. Python programming and interfacing for Raspberry Pi.
4. Design IoT applications in different domains.

UNIT – I

Introduction to Internet of Things, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT, Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks.

UNIT – II

Machine-to-Machine Communications, Difference between IoT and M2M, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino,

UNIT – III

Introduction to Python programming, Introduction to Raspberry Pi, Interfacing Raspberry Pi with basic peripherals, Implementation of IoT with Raspberry Pi

UNIT - IV

Implementation of IoT with Raspberry Pi, Introduction to Software defined Network (SDN), SDN for IoT, Data Handling and Analytics,

UNIT - V

Cloud Computing, Sensor-Cloud, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring

Suggested Readings:

1. "The Internet 'of Things: Enabling Technologies, Platforms, and Use Cases", by PethuruRaj and Anupama C. Raman (CRC Press).
2. “Make sensors”: Terokarvinen, kemo, karvinen and villeyvaltokari, 1st edition, maker media, 2014.
3. "Internet of Things: A Hands-on Approach", by ArshdeepBahga and Vijay Madisetti Vijay Madisetti,
4. ArshdeepBahga, “Internet of Things: A Hands-On Approach”
5. WaltenegusDargie,ChristianPoellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"
6. Beginning Sensor networks with Arduino and Raspberry Pi – Charles Bell, Apress, 2013

OE948

CYBER SECURITY

(Open Elective)

Instruction: 3periods per week | Duration of SEE: 3 hours
CIE: 30 marks | SEE: 70 marks
Credits: 3

Course Objectives

- Learn the various threats in networks and security concepts.
- Apply authentication applications in different networks.
- Understand security services for email.
- Awareness of firewall and IT laws and policies

Course Outcomes:

After completion of this course, the students shall be able to:

1. Understand the various network threats.
2. Analyze the forensic tools for evidence collection.
3. Apply the firewalls for threat analysis.

UNIT-I

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

UNIT-II

Introduction to Digital forensics, Forensic software and handling, forensic hardware and handling, analysis and advanced tools, forensic technology and practices, Biometrics: face, iris and fingerprint recognition, Audio-video evidence collection, Preservation and Forensic Analysis.

UNIT-III

Investigation Tools, e-discovery, EDRM Models, digital evidence collection and preservation, email investigation, email tracking, IP tracking, email recovery, searc and seizure of computer systems, password cracking.

UNIT-IV

Forensic Analysis of OS artifact, Internet Artifacts, File System Artifacts, Registry Artifacts, Application Artifacts, Report Writing, Mobile Forensic- identification, collection and preservation of mobile evidences, social media analysis, data retrival, Email analysis from mobile phones.

UNIT-V

Ethics, Policies and IT Act Basics of Law and Technology, Introduction to Indian Laws, Scope and Jurisprudence, Digital Signatures, E Commerce-an Introduction, possible crime scenarios, law coverage, data interchange, mobile communication development, smart card and expert systems Indian Laws, Information Technology Act 2000, Indian Evidence Act, India Technology Amendment Act 2008, Indian Penal Code , Computer Security Act 1987,

National Information Infrastructure Protection Act 1996, Fraud Act 1997, Children Online Protection Act 1998, Computer Fraud and Abuse Act 2001, Intellectual Property, IP Theft, Copyright, Trademark, Privacy and Censorship, Introduction to Cyber Ethics, rights over intellectual property, Corporate IT Policy Formulations, Compliance Auditing.

Suggested Readings

1. Charles P. Fleeger, "*Security in Computing*", Prentice Hall, New Delhi, 2009.
2. BehrouzA.Forouzan, "*Cryptography & Network Security*", Tata McGraw Hill, India, New Delhi, 2009.
3. William Stallings, "*Cryptography and Network Security*", Prentice Hall, New Delhi, 2006.
4. Chalie Kaufman, Radia Perlman, Mike Speciner, "*Network Security: Private Communication in a Public Network*", Pearson Education, New Delhi, 2004.
5. Neal Krawetz, "*Introduction to Network Security*", Thomson Learning, Boston, 2007.
6. Bruce Schneier, "*Applied Cryptography*", John Wiley & Sons, New York, 2004.

CE 481

MAJOR PROJECT PHASE-I

Instruction: 6 periods per week *Duration of SEE: -- hours*
CIE: 100 marks *SEE: -- marks*
Credits: 10

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:

At the end of the course, the student shall be able to:

1. *Identify a research gap based on the review of literature and try to innovate with set objective based on experimental /analytical / simulation in transportation Engineering and Literature Review*
2. *Recognize procedure and research methodology with a concern of society/Environmental and ethics*
3. *Prepare a report/documentation in a standard format*
4. *Presentation in order with appropriate figures and PPT*
5. *Performance on viva voce to defend the work based on subject knowledge using PPT*

Each student will be attached to a faculty member, (guide) for Major Project Phase-I during the Third Semester. The student will carry out the literature and methodology of 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 Major Project Phase-I is offered. The sessional marks will be awarded jointly by these two examiners based on the report, the presentation and viva voce.

With effect from academic year 2021-22

SEMESTER-IV

CE 482

MAJOR PROJECT PHASE-II

Instruction: 6 periods per week *Duration of SEE: -- hours*
CIE: 200 marks *SEE: -- marks*
Credits: 16

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:

1. *Develop on the defined research problem in dissertation.*
2. *Carry out laboratory/analytical studies.*
3. *Evaluate data, develop models, offer solutions and give conclusions.*
4. *Present research in the form of report*
5. *Performance on viva voce to defend the work based on subject knowledge using PPT*

Each student will continue the project in Major Project Phase-II during fourth semester which is based on the work decided in earlier 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.