KERALA TECHNOLOGICAL UNIVERSITY

Master of Technology

Curriculum, Syllabus and Course Plan

Cluster	**:**	*01*
Branch	**:**	*Civil Engineering*
Stream	**:**	*Traffic and Transportation Engineering*
Year	**:**	*2015*
No. of Credits	**:**	*67*

SEMESTER 1

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	01MA6003	Applied Probability and Statistics	3-0-0	40	60	3	3
B	01CE6501	Pavement Materials and construction	3-1-0	40	60	3	4
C	01CE6503	Urban Transportation Planning	3-1-0	40	60	3	4
D	01CE6505	Traffic Engineering–I	3-0-0	40	60	3	3
E		Elective I	3-0-0	40	60	3	3
S	01CE6999	Research Methodology	0-2-0	100			2
T	01CE6591	Seminar I	0-0-2	100			2
U	01CE6593	Traffic Engineering and Software Lab	0-0-2	100			1
		TOTAL	**15-4-4**	**500**	**300**	**-**	**22**

TOTAL CONTACT HOURS : 23
TOTAL CREDITS : 22

Elective I

01CE6511 Highway design and Safety

01CE6513 Operations Research

01CE6515 Project Management

SEMESTER 2

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	01CE6502	Analysis and Design of Pavement System	3-1-0	40	60	3	4
B	01CE6504	Transportation Economics and Appraisal	3-0-0	40	60	3	3
C	01CE6506	Traffic Engineering –II	3-0-0	40	60	3	3
D		Elective II	3-0-0	40	60	3	3
E		Elective III	3-0-0	40	60	3	3
V	01CE6592	Mini Project	0-0-4	100			2
U	01CE6594	Pavement Materials and Evaluation Lab	0-0-2	100			1
		TOTAL	**15-1-6**	**400**	**300**	**-**	**19**

TOTAL CONTACT HOURS : 22
TOTAL CREDITS : 19

Elective II

01CE6512 Analysis and design of Intersection
01CE6514 Pavement Evaluation and Management
01CE6516 Regional Transportation Planning

Elective III

01CE6518 Intelligent Transportation System
01CE6622 Geoinformatics in Transportation Engineering
01CE6522 Sustainable Transportation

SEMESTER 3

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A		Elective IV	3-0-0	40	60	3	3
B		Elective V	3-0-0	40	60	3	3
T	01CE7591	Seminar II	0-0-2	100			2
W	01CE7593	Project (Phase 1)	0-0-12	50			6
		TOTAL	**6-0-14**	**230**	**120**	**-**	**14**

TOTAL CONTACT HOURS : 20
TOTAL CREDITS : 14

Elective IV

01CE7511 Traffic Simulation Modelling and Applications

01CE7513 Advanced Travel Demand Modelling

01CE7515 Public Transportation System

Elective V

01CE7517 Analytical Techniques in Transportation Planning

01CE7519 Application of Geo-Synthetics in pavements

01CE7521 Advanced Optimisation Techniques for Transportation Engineering

SEMESTER 4

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credit
					Marks	Duration (hours)	
W	01CE7594	Project (Phase 2)	0-0-23	70	30		12
		TOTAL	**0-0-23**	**70**	**30**	**-**	**12**

TOTAL CONTACT HOURS : 23
TOTAL CREDITS : 12

TOTAL NUMBER OF CREDITS: 67

SEMESTER - I

Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01MA6003	Applied Probability and Statistics	**3-0-0**	**3**	**2015**

Course Objectives

To equip the students with the basic concepts in probability distributions, statistical inference, Correlation and regression analysis, design of experiments and time series.

Syllabus

Probability distributions-discrete and continuous-standard distributions-fitting of distributions-

Sampling techniques-statistical inference-estimation and testing of hypothesis-regression analysis-

Analysis of variance - Completely randomized designs -Randomized block designs. Latin Squares, Factorial experiments, Graphical presentation techniques. Time series models-covariance matrix and principal components

Expected Outcome

After successful completion of the course, students should make use of the statistical procedures in the modelling of data in their field of study.

References

1. Gupta S.C. and Kapoor V.K, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 1978.
2. Benjamin Jack R. and Comell C. Allin, Probability Statistics and Decision for Civil Engineers, Mc-Graw Hill, 1997
3. Richard A. Johnson, Miller and Freunds, Probablity and Statistics for Engineers, Prentice Hall of India, 2007
4. Dallas E Johnson, Applied multivariate methods for data analysis, Thomson & Duxbburg Press, Singapore, 2002
5. Jay L. Devore, Probability and statistics for Engineering and Sciences, Thomson and Duxbburg Press, Singapore, 2002
6. Richard A Johnson and Dean W. Wichern, Applied multivariate statistical analysis, Pearson Education, 2002
7. Irwin Miller& Marylees Miller: Mathematical Statistics :Pearson Education Inc 2004

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Probability mass functions and probability density function, distribution functions, mean and variance. Binomial, Poisson, Exponential, Gamma, and Normal distribution, Mean and variance-Fitting of distributions (brief overview only)-computing probability using the above distributions.	7	15
II	Statistical Inference: Sampling distributions- Interval estimation, Confidence interval for mean, variance and regression coefficients., test of significance of (i) Mean (ii) Mean of two samples (iii)Proportions (iv) Variance (v) Two variance (vi) Paired t-test (vii) Chi-square test of goodness of fit (viii) Chi-square test for independence	**7**	15
FIRST INTERNAL EXAM			
III	Linear regression and correlation, method of least squares, normal regression analysis, normal correlation analysis, multiple linear regression, multiple correlation co-efficient.	**7**	15%
IV	Analysis of variance – One way designs, randomized block designs - Factorial experiments -Latin Square designs, applications. Graphical presentation techniques.	**7**	15%
SECOND INTERNAL EXAM			
V	Time Series Models: Components of time series – smoothing – measuring forecasting accuracy – testing of ARIMA models.	**7**	20%
VI	Multivariate Analysis: Co-variance matrix- correlation matrix- multivariate normal density function, principal components- sample variation by principal components-principal components by graphs	**7**	20%
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6501	Pavement Materials and construction	**3-1-0**	**4**	**2015**

Course Objectives

1. To understand the characteristics and tests for flexible and rigid pavement materials.
2. To understand Properties, characteristics and design of mixes of bituminous and concrete mix types commonly used for road constructions.
3. Tostudyrecentdevelopmentsinconstructionpracticesandmodernequipment'sused.
4. To get awareness/importance for recycling process advanced test procedures and improved mixes/layers.

Syllabus

Relevance of subgrade soil as a foundation for pavements with detailed investigation on characteristics, soil classification systems and soil stabilisation techniques.

Materials used for pavement construction like aggregates, bitumen, emulsion, cutback etc, their characteristics and tests.

Bituminous pavement mixes- types, properties and different mix design methods

Construction procedures for various pavement component layers and study on latest equipment used for pavement constructions.

Rigid pavement construction procedures and procedures for recycling of existing pavements for sustainable development.

Interlocking block pavements, Non-destructive tests and speciality applications on pavement engineering.

Expected Outcome

1. Understand the need for tests and procedures adopted for Pavement construction.
2. Toequipthestudentswithpracticalsenseofroadconstructionusingsuitablematerials based on its properties.

References

1. P. H. Wrightand Karen Dixon, Highway Engineering, John Wiley & Sons, 1996.
2. Rajib B. Mallick and TaharEl-Korchi, Pavement Engineering CRC press, 2009.
3. Manual for construction and supervision of Bituminous works, MoRTH 2001.
4. R.N.Hunter, Bituminous Mixtures in Road Construction, Thomas Telford ServicesLtd1995.
5. IRC SP: 63-2004 "Guidelines for Use of Interlocking Concrete Block Pavement" Indian Roads Congress.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Characterization of subgrade soil/granular materials, Soil classification systems regarding suitability as subgrade soil, Resilient Modulus of soil/granular materials, Soil stabilization methods-Chemical and Mechanical and their construction procedures.	8	15
II	Road aggregates, Principles and methods of Gradation for soil–Aggregate mixes. Artificial aggregates. Bituminous binders–Methods of grading, Emulsions–Properties and tests, Cutback sand Modified binders-Types, characteristics and uses, Aging of bitumen and aging tests.	8	15
FIRST INTERNAL EXAM			
III	Bituminous pavement types: - Penetration layer systems and Premixed aggregate and bituminous mixtures, Physical and volumetric properties of bituminous mixes. Mix Design-Marshall Method and Superpave procedure, Tests on materials for super pave mix design.	10	15
IV	Recovery of bituminous binder from bituminous mix Design of emulsified mixes, Construction of bituminous pavements-Preparation and construction of Base, Sub base and surface layers. Equipments used for the construction of different layers in both flexible and rigid pavements.	10	15
SECOND INTERNAL EXAM			
V	Material characterization for Cement concrete pavements, Construction of Cement concrete pavements–Preparation of Subgrade and Base, Presetting reinforcements in joints and PCC slab construction stages. Recycling of pavements-Hot mix recycling, hot in place recycling, cold in place recycling and full depth reclamation.	10	20
VI	Interlocking concrete block pavements, characteristics and design as per IRC. Non-destructive tests-Nuclear Gauge, Geogauge, Ground penetrating radar. Specialty Applications- Stone Matrix Asphalt, Warm mix asphalt, Porous pavements, Thin white topping and ultra-thin white topping.	10	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6503	Urban Transportation Planning	**3-1-0**	**4**	**2015**

Course Objectives

1. To introduce the role of planning in analysing and modelling travel demand
2. To understand the stages involved in the Urban Transportation Planning process
3. To study the principle of land use transport interaction models, it's mathematical formulation and solution

Syllabus

Systems approach to UTP concepts: Flowcharts, Travel demand concepts
Definitions: Zoning, Sampling, Data collection techniques, OD surveys, Trip types
Travel demand estimation: Trip generation & Regression analysis and Model types
Category analysis: Trip distribution analysis, Growth & Opportunity models
Modal split analysis: Modelling travel behaviour, Probabilistic & Trip assignment models
Land use-transport models: Lowry model & Lowry Garin model

Expected Outcome

1. Understand the various transportation planning concepts
2. Understand four step modelling concept in Urban Transportation Planning

Familiarise the mathematical travel demand model development concepts and its solutions

References

1. Hutchinson. B. G, Principles of urban transportation planning, McGraw Hill, New York
2. Dickey. J. W, Metropolitan transportation planning, McGraw Hill, New York.
3. Meyer D Michael and Miller Eric J, Urban transportation planning: a decision-oriented approach, McGraw Hill
4. Bruton M.J, Introduction to transportation planning, Hutchinson, London
5. Partha Chakroborty, Principles of Transportation Engineering, Animesh Das Prentice-Hall, India.
6. Kadiyali L.R, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Systems approach to urban transportation planning concepts; flow chart for transportation planning process. Inventory of transportation system, Travel demand concepts, Data needs for planning process, Use of secondary data.	9	15
II	Definition of the study area. Cordon line, screen line, Zoning, sample size determination, Data collection techniques. O-D surveys. Introduction to sequential travel demand modelling- trips, types.	9	15
FIRST INTERNAL EXAM			
III	Travel demand estimation; Trip generation analysis-Aggregate analysis, dis-aggregate analysis, Regression analysis. Types of regression models-linear, non-linear, multiple regression models.	9	15
IV	Category analysis. Trip distribution analysis. Growth models- Fratar and Furness models. Various forms of the gravity models. Opportunity models- Intervening opportunity and competing opportunity models. Application of entropy concepts in travel demand modelling.	9	15
SECOND INTERNAL EXAM			
V	Modal split analysis, Modelling travel behaviour. Aggregate and Dis-aggregate Models, Probabilistic models- Probit and logit models. Trip assignment models. Minimum path assignment. All or nothing assignment, Equilibrium assignment, Capacity restrained assignment, Multiple path assignment. Diversion curves.	10	20
VI	Land use-transport models. Lowry model. Lowry Garin model. Iterative solutions. Introduction to transport planning softwares.	10	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6505	Traffic Engineering–I	**3-0-0**	**3**	**2015**

Course Objectives

1. To understand the different phases of traffic engineering
2. To study the various surveys conducted in traffic Engineering and how to analyse the various parameters
3. TohaveanideaabouttherulesandregulationsprevailingintrafficEngineering

Syllabus

Components and characteristics of Traffic stream: road traffic, vehicle and road user
Traffic stream parameters: Fundamental diagrams of traffic flow, PCU concepts
Traffic surveys-Data collection and analysis of various traffic parameters
Studies on parking, headway, pedestrian, accident and Congestion
Application of probability and statistics in traffic Engineering
Traffic controls and regulations, Design of intersections- signals, traffic management measures
Road Safety audit and safety measures.

Expected Outcome

1. Understand the various elements in traffic engineering
2. Analyse the significance of various parameters in traffic scenario.
3. Awareness to various traffic control devices and how to implement traffic safety

References

1. Roess R P, McShane WR & Prassas ES, Traffic Engineering, Prentice Hall, 3rd edition2004
2. Pignataro L. J, Traffic Engineering, Theory and Practice (1983)
3. May, Traffic Flow Fundamentals, Prentice Hall, 1989
4. Kadiyali. L R. 'Traffic Engineering and Transport Planning', Khanna Publishers, 7th edition2008
5. Matson, Smith and Hurd, 'Traffic Engineering', McGraw Hill Book Co.
6. Wells, GR, 'Traffic Engineering-An Introduction', Griffin, London
7. Chakraborthy Partha , Das Animesh, Principles of Transportation Engineering, PHI Learning Pvt.Ltd.,2009
8. IRC Publications

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Objectivesandscopeoftrafficengineering-ComponentsandcharacteristicsofTrafficstream- Microscopic and Macroscopic characteristics-Components of road traffic-the vehicle, static and dynamic characteristics of vehicles, driver and road user, Road characteristics	6	15
II	Traffic stream parameters–Fundamental diagrams of traffic flow. Flow at different densities- Shock wave phenomenon, Concept of PCU and methods of determination of PCU values, Studies on PCU determination under heterogeneous traffic.	6	15
FIRST INTERNAL EXAM			
III	Traffic Surveys- Data collection and Analysis-Measurement of traffic parameters like volume, speed, concentration, parking, travel time and delay, headways and Gaps, Critical Gap-Gap acceptance studies, pedestrian studies, accident studies. Congestion studies: Performance measures, intensity, duration, extent of congestion, traveler perception, remedial measures.	8	15
IV	Application of probability and statistics in traffic Engineering-fitting of distributions, sampling in traffic studies, statistical analysis of traffic stream parameters	7	15
SECOND INTERNAL EXAM			
V	Traffic Controls and Regulations-Traffic Signs and Road Markings-design of at grade intersections-principles and design- channelization-design of rotaries-traffic signals-pre timed and actuated-design of signal setting-phase diagrams, timing diagram- signal coordination-other traffic control aids-Advanced technologies of traffic control	8	20
VI	Grade separated intersection-Geometric elements for divided and access controlled highways and expressways- Road furniture-street lighting, design and analysis-.Traffic laws and ordinances-General regulations, Regulations on vehicles, drivers, pedestrians and traffic-regulations on speed-speed zoning-parking regulations-enforcement of regulations. Road safety audit and safety measures, traffic management measures.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6311	Highway Design and Safety	**3-0-0**	**3**	**2015**

Course Objectives

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

Syllabus

Highway function and safety: Factors involved in crashes, Road way design and Indian road safety
Planning of road network : Land use, design for safety and safety analysis
Crashes: Types, assessment of accident spots, crash summary report and counter measures
Safety issues: Human factors approach, Safety in public transport, Night driving and safety at construction zones.
Road safety audit: Objectives and various aspects of audit including design, Road safety audit report

Expected Outcome

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

References

1. Highway Design and Traffic Safety Engineering Handbook, Ruediger Lamm, Basil sarianos, and Theodor Mailaender, McGraw Hill Handbooks.
2. Manual on Uniform Traffic Control Devices [MUTCD].
3. KadiyaliL.R. Traffic Engineering and Transport Planning, Khanna Publishers, NewDelhi.
4. Hobbs. F.D. Traffic Planning and Engineering, Pergamon Press.
5. Pignataro. L.J, Traffic Engineering: theory and practice, Prentice Hall.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Highway functions and safety Highway functions; highway safety:road,vehicle and human factors in crashes	6	15
II	Roadway Design, Design speeds; horizontal alignment ;super elevation; Vertical alignment; sight distance; spiral curves; Cross sections design: lanes, medians and footpaths; grade intersection; low volume intersections ;global and Indian road safety scenario.	6	15
	FIRST INTERNAL EXAM		
III	Planning of road network Land use and road environment for safety, road link design for safety. Safety Analysis: Statistical Models, prediction models, accident rate modeling, speed models.	8	15
IV	Road crashes: Types and causes of crashes, assessment of high collision sites, collision diagram, crash factor matrix, preliminary report, crash summary report accident forensic investigation, accident reconstruction; expert witness analysis; field studies; safety enhancement projects; crash counter measures, crash location treatment report	8	15
	SECOND INTERNAL EXAM		
V	Safety Issues Human factors approach: For giving designs, safety issues of vulnerable road users: bicycle/pedestrian safety and traffic control devices for safety; safety issues in public transport; bus stops and bus bays; Night time driving:visibility,road lighting and retro-reflectivity of signs and markings; Safety at construction zones-Enforcement and regulations	8	20
VI	Road Safety Audit objectives-conduct of road safety audit-stages-feasibility stage-preliminary design stage-detailed design stage-construction stage-preopening audit-audit of existing roads-night time audit-check lists-road safety audit report	6	20
	END SEMESTER EXAM		

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6513	Operations Research	**3-0-0**	**3**	**2015**

Course Objectives

1. To introduce the methods of Operations Research
2. Emphasize the mathematical procedures of linear and nonlinear programming

Syllabus

Introduction to Operations Research-Formulation of LPP--Simplex Method, Duality Theory- Sensitivity Analysis-parametric programming: Integer Programming-cutting plane method-mixed integer programming-branch and bound methods. Inventory models-Models with deterministic demand – Nonlinear programming- Lagrange multiplier method- Kuhn Tucker conditions-Quadratic programming.

Expected Outcome

1. Proficiency in tools in optimization
2. To enable the students to build models for simple problems in managerial decision making and utilize proper mathematical methods to solve these models

References

1. Bazaraa M S, Jarvis & herali H D ,Linear Programming and Network flows, John Wiley & Sons,Singapore 1990.
2. Bazaraa M S, Sherali H D & Shetty,C. M.,Non Linear Programming,Theory & Algorithms 2nd edition, John Wiley &Sons,Singapore 1995.
3. Goel B S and Mittal S K ' Operations Research' 1999
4. Taha, Hamdy, Operations Research, 7th edition, (USA: Macmillan Publishing Company), 2003

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem – Formulation of LPP, Simplex Method, Artificial variables, Big-M method, two-phase method, degeneracy and unbound solutions.	6	15
II	Duality Theory, The Primal Vs- Dual-Solutions. Sensitivity Analysis: Changes in Objective-Function Sensitivity Analysis: Changes in RHS.- revised simplex method –parametric programming	6	15
FIRST INTERNAL EXAM			
III	Integer programming-relevance of integer variables and relevance of integer programming- formulation of problems with binary variables-cutting plane method-mixed integer programming-branch and bound methods.	8	15
IV	Inventory models. Inventory costs. Models with deterministic demand – demand rate uniform and production rate infinite - demand rate non-uniform and production rate infinite - demand rate uniform and production rate finite	8	15
SECOND INTERNAL EXAM			
V	Non linear programming-multi-variable optimisation with equality constraints- Langarange multiplier method-optimisation in the presence of inequality constraints-convexity and role in optimization- Kuhn Tucker conditions	8	20
VI	Quadratic programming-Wolf's method- Beale's method-Frank &Wolfe Method, Reduced Gradient method, Gradient projection method, convex simplex method, Penalty and Barrier methods.	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6515	Project Management	**3-0-0**	**3**	**2015**

Course Objectives

1. To execute the project most economically both in terms of money and time.
2. To understand the importance of the preparation of project feasibility report.

Syllabus

Project Management Concepts, Organizational Structures and project constraints, Time Cost relationship and applications, Safety management in construction and its economy, Optimization of cost through network contraction, Contracts in construction management and Contractual obligations, Phases and applications of value engineering, Human relations in construction management- Data base and its benefits- The role of data base approach to contractors account.

Expected Outcome

1. To understand the present needs and future utilities, all are given due weightages in the planning process.
2. To equip the students with good managerial skills

References

1. Heroil Keenzer–Project Management–A system approach to planning, scheduling and controlling–CBS publishers distributers 1997.
2. K.Waker ATeraihand Jose MGrevarn: Fundamentals of Construction Management & Organization.
3. Ghattas and Mckee–Practical Project Management–Pearson Education2002.
4. Seetharaman-Construction Engineering and Management–Umesh Publications2012.
5. Shore.B Operations Managements Mc.Graw Hill1973.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Project Management Concepts -Organization function and objectives, system theory, –Organizational Structures Tools and Techniques–concepts, functions. Objectives of management-qualities and duties of each component – Project Constrains –Project Feasibility Reports. Change–external forces, effect, responses, approaches, acceptance.	6	15
II	Teambuilding–Recognition, Elements construction, Challenges. Goal setting–Development. Estimates – objectives – different types–cost control – project cost–tool and techniques of cost forecasting. Resource planning–Principles–optimization of cost and resource utilization. Time cost relationship and applications of Linear Programming	6	15
FIRST INTERNAL EXAM			
III	Materials Management – Importance, objectives, functions, uses–stores management-procurements, handling. Safety management in construction. Sensitivity analysis. Scheduling–optimization–Elements of Network, error in networks – Network analysis –CPM and PERT –Use of CPM and PERT in cost accounting system –smoothing and leveling of network models. LOB Technique.	8	15
IV	Types of Contract- Documentation, condition, pre-tender planning. Pre-contract planning-Establishing contract budgets, forecasting, contract value–laws of contract, potential problems, arbitration–post contract problems–special feature of international contracts.	7	15
SECOND INTERNAL EXAM			
V	DPR Preparation with reference to World Bank Projects. Value Engineering and Quality assurance, Life cycle costing, Manpower planning, training, motivation, performance evaluation, and Industrial relations – Welfare measures.	8	20
VI	Human factors in Construction. Leadership and Motivation – influence–Effective delegation-Accountability, authority and autonomy. Communication–Needs, styles, understanding, effectiveness, appreciation. MIS components and structure – Data base approach to the contractor and user, Personnel management.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6999	Research Methodology	**0-2-0**	**2**	**2015**

Course Objectives

1. To prepare the student to do the M. Tech project work with a research bias.
2. To formulate a viable research question.
3. To develop skill in the critical analysis of research articles and reports.
4. To analyze the benefits and drawbacks of different methodologies.
5. To understand how to write a technical paper based on research findings.

Syllabus

Introduction to Research Methodology-Types of research- Ethical issues- Copy right-royalty-Intellectual property rights and patent law-Copy left- Open access-Analysis of sample research papers to understand various aspects of research methodology:

Defining and formulating the research problem-Literature review-Development of working hypothesis-Research design and methods- Data Collection and analysis- Technical writing- Project work on a simple research problem

Approach

Course focuses on students' application of the course content to their unique research interests. The various topics will be addressed through hands on sessions.

Expected Outcome

Upon successful completion of this course, students will be able to

1. Understand research concepts in terms of identifying the research problem
2. Propose possible solutions based on research
3. Write a technical paper based on the findings.
4. Get a good exposure to a domain of interest.
5. Get a good domain and experience to pursue future research activities.

References

1. C. R. Kothari, Research Methodology, New Age International, 2004
2. Panneerselvam, Research Methodology, Prentice Hall of India, New Delhi, 2012.
3. J. W. Bames, Statistical Analysis for Engineers and Scientists, Tata McGraw-Hill, New York.
4. Donald Cooper, Business Research Methods, Tata McGraw-Hill, New Delhi.
5. Leedy P. D., Practical Research: Planning and Design, McMillan Publishing Co.
6. Day R. A., How to Write and Publish a Scientific Paper, Cambridge University Press, 1989.
7. Manna, Chakraborti, Values and Ethics in Business Profession, Prentice Hall of India, New Delhi, 2012.
8. Sople, Managing Intellectual Property: The Strategic Imperative, Prentice Hall of India, New Delhi, 2012.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Introduction to Research Methodology: Motivation towards research - Types of research: Find examples from literature. Professional ethics in research - Ethical issues-ethical committees. Copy right - royalty - Intellectual property rights and patent law - Copy left-Open access-Reproduction of published material - Plagiarism - Citation and acknowledgement. Impact factor. Identifying major conferences and important journals in the concerned area. Collection of at least 4 papers in the area.	5	
II	Defining and formulating the research problem -Literature Survey-Analyze the chosen papers and understand how the authors have undertaken literature review, identified the research gaps, arrived at their objectives, formulated their problem and developed a hypothesis.	4	
FIRST ASSESSMENT			
III	Research design and methods: Analyze the chosen papers to understand formulation of research methods and analytical and experimental methods used. Study of how different it is from previous works.	4	No end semester written examination
IV	Data Collection and analysis. Analyze the chosen papers and study the methods of data collection used. - Data Processing and Analysis strategies used– Study the tools used for analyzing the data.	5	
SECOND ASSESSMENT			
V	Technical writing - Structure and components, contents of a typical technical paper, difference between abstract and conclusion, layout, illustrations and tables, bibliography, referencing and footnotes-use of tools like Latex.	5	
VI	Identification of a simple research problem – Literature survey-Research design- Methodology –paper writing based on a hypothetical result.	5	
END SEMESTER ASSESSMENT			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6591	Seminar I	**0-0-2**	**2**	**2015**

Course Objectives

To make students

1. Identify the current topics in the specific stream.
2. Collect the recent publications related to the identified topics.
3. Do a detailed study of a selected topic based on current journals, published papers and books.
4. Present a seminar on the selected topic on which a detailed study has been done.
5. Improve the writing and presentation skills.

Approach

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

Expected Outcome

Upon successful completion of the seminar, the student should be able to

1. Get good exposure in the current topics in the specific stream.
2. Improve the writing and presentation skills.
3. Explore domains of interest so as to pursue the course project.

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6593	Traffic Engineering and Software Lab	**0-0-2**	**1**	**2015**

Expt. no:	Title	Hours Allotted

Course Objectives

1. To introduce the practical problems on traffic engineering and road safety
2. To introduce the analysis software's
3. To introduce the transportation planning software's

LIST OF EXPERIMENTS

1.	Traffic control devices inventory	(3hrs)
2.	Travel time and delay study	(3hrs)
3.	Spot speed study	(2hrs)
4.	Turning movement and peak hour factor	(3hrs)
5.	Sight distance and gap study at intersections	(3hrs)
6.	Saturation flow rates	(3hrs)
7.	Level of service analysis	(3hrs)
8.	Parking study	(3hrs)
9.	Pedestrian facilities	(3hrs)
10.	Traffic impact studies	(3hrs)
11.	Transportation system performance monitoring	(4hrs)
12.	Transportation and air quality management	(3hrs)
13.	Application of queuing analysis	(3hrs)
14.	Intelligent transportation system	(3 hrs)
15.	Computer software applications in transportation and traffic engineering	

a) Introduction to Trans CAD
b) Introduction to EMME
c) Application of Planning Software

Expected Outcome

1.Knowledge on analyzing and solving traffic engineering problems
2.Ability to work with transportation planning software's
3.Ability to conduct road safety audits

1	Traffic control devices inventory	**3**
2	Travel time and delay study	3
3	Spot speed study	2
4	Turning movement and peak hour factor	**3**
5	Sight distance and gap study at intersections	**3**
6	Saturation flow rates	**3**
7	Level of service analysis	**3**
8	Parking study	**3**
9	Pedestrian facilities	**3**
10	Traffic impact studies	**3**
11	Transportation system performance monitoring	**4**
12	Transportation and air quality management	**3**
13	Application of queuing analysis	**3**
14	Intelligent transportation system	**3**
15	Computer software Applications in Transportation and Traffic Engineering	
	a. Introduction to Trans CAD	
	b. Introduction to Trans EMME	
	c. Application of Planning Software	

SEMESTER – II

Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6502	Analysis and Design of Pavement Systems	**3-1-0**	**4**	**2015**

Course Objectives

1. To understand the load distribution characteristics of flexible and rigid pavements
2. To understand the development of stresses and strains within the pavement system
3. To study various pavement design methods

Syllabus

Introduction to pavements, sub systems, factors affecting pavement design
Material characterization, Visco-elastic theory, Failure criteria for design of pavements
Stresses and strains in flexible pavements, Burmister's layer theory
Design of flexible pavements: IRC Method, Asphalt Institute Method, AASHTO Method, Pavement drainage system
Stresses in rigid pavements, Design of rigid pavements: IRC, AASHTO and PCA method
Design of continuously reinforced concrete pavements, Joints in cement concrete pavements, Spacing of joints, Design of dowel bars and tie bars (IRC method). Introduction to softwares used for design of pavements.

Expected Outcome

1. Understand the fundamentals of stress distribution within a pavement system
2. To equip the students to analyse the stresses and design pavements with better performance and longer service life

References

1.Yang H. Huang, Pavement Analysis and Design, Prentice Hall, 2004

2. Yoder and Witczak, Principles of Pavement Design, John Wiley and sons, 2007

3. Rajib B. Mallick and Tahar El-Korchi, Pavement Engineering – Principles and Practice, CRC Press (Taylor and Francis Group)

4. Latest revisions of IRC codes: IRC: 37 and IRC: 58

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Introduction to Pavements: Types of pavements, Flexible and rigid pavements, Functions of individual layers, Highway and airport pavements Variables Considered in Pavement Design: Traffic factors, Material properties, Climatic effects Traffic Analysis: ADT, AADT, Truck Factor, Growth Factor, Lane Distribution and Vehicle Damage Factor	8	15
II	Material characterization: Resilient Modulus, Dynamic modulus and Fatigue characteristics of bituminous mix, Visco-elastic theory and assumptions, Failure criteria for design of pavements	8	15
FIRST INTERNAL EXAM			
III	Stresses and strains in flexible pavements: Stress inducing factors in flexible pavements, Vehicle-Pavement interaction, Stresses and deflections in homogeneous soil mass, Load equivalency factor, Burmister's layer theory: Solutions for one, two and three layered pavement systems.	10	15
IV	Principles of Mechanistic- Empirical Pavement Design (MEPD), Methods of flexible pavement design: IRC Method, Asphalt Institute Method, AASHTO Method.	10	15
SECOND INTERNAL EXAM			
V	Stresses in Rigid Pavements: Westergaards theory and assumptions, Types of stresses: Wheel load stresses, Temperature stresses, Critical combination of stresses. Rigid pavement design methods: IRC method, AASHTO method and PCA method.	10	20
VI	Design of continuously reinforced concrete pavements Types of joints in cement concrete pavements – functions and requirements Joint spacing – Design of dowel bars and tie bars (IRC method). Introduction to softwares for design of pavements	10	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6504	Transportation Economics and Appraisal	**3-0-0**	**3**	**2015**

Course Objectives

1. To provide solid introduction to transportation demand and cost analyses.
2. Identification of various costs and benefits associated with high way construction, fare policy for bus transit, pricing theory, congestion pricing etc.
3. To introduce the various compound interest equations and various methods of economic analysis.
4. Introduction to the econometrics of industrial location, various stages of project appraisal and preparation of feasibility report are covered.

Syllabus

Demand and supply of transport, Elasticity of demand and supply concepts. Costs and Benefits Identification and measurements of transportation costs and benefits, Accident cost, Congestion cost and pricing, Consumer's surplus and social surplus criteria, Fare policy for bus transit. Econometrics and Project Appraisal, Social Cost Benefit analysis, Economic and financial appraisal, Financing transport infrastructure, preparation of projects, Feasibility reports. Economic Analysis, Indirect costs and benefits of transportation projects, Economic evaluation of mass transit projects.

Expected Outcome

1. Understandtheprincipleofeconomicsanditsapplicationintransportation
2. Understand the benefits and costs associated with various transport projects and its monetary evaluation
3. Familiarisation with the application of various methods of economic analysis and their comparison.

References

1. Stuart Cole, 'Applied Transport Economics'
2. KMG Williams and P.J. Mackie 'Economics and Transport Policy'
3. L. R. Kadiyali 'Traffic Engineering and Transport Planning'
4. Fair and Williams 'Economics of Transportation'
5. Herbert Mohring 'Transportation Economics'
6. John Lansing 'Transportation and Economic Policy'
7. Dominick Sabratore - Schaum's Outline series 'Theory and problems of microeconomic theory'
8. Winfrey-Transport Economics
9. Dr.P.K.Sarkar,'TransportEconomics'.StandardPublishersandDistributors
10.Dr.Vinay Maitri, Dr.P.K.Sarkar, Theory & Applications of Economics in Highway & Transport Planning, Standard Publishers and Distributors

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Introduction Significance of transport, Demand and supply of transport, Elasticity of demand and supply concepts and principles of highway engineering economy. Costs and Benefits Identification and measurements of transportation costs and benefits, Capital cost, Inflation cost Interest during construction, Maintenance cost, Road user costs, Fixed and operating costs.	6	15
II	Accident cost ,Methodology for monetary evaluation of passenger's travel time, Value of increased comfort and convenience, Congestion cost and pricing, Consumer's surplus and social surplus criteria, Fare policy for bus transit	6	15
FIRST INTERNAL EXAM			
III	Econometrics & Project Appraisal, Econometrics of industrial location, Project Appraisal-Technical Appraisal, Social Appraisal-Social Cost Benefit analysis, Economic and financial appraisal	6	15
IV	Financing transport infrastructure - Appraisal through financial statement, Taxation, and Toll collection. Preparation of projects, Feasibility reports.	8	15
SECOND INTERNAL EXAM			
V	Interest and Economic Analysis Compound interest equations, discount cash flow, Method of economic evaluation-Rate of return, Net present value. Internal rate of' return method, First year rate of return, Present worth of cost, EUAC, Benefit cost ratio.	8	20
VI	Indirect costs and benefits of transportation projects, Comparison of various methods of economics analysis, case studies and problems, Economic evaluation of mass transit projects.	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6506	Traffic Engineering II	**3-0-0**	**3**	**2015**

Course Objectives

1. To introduce the fundamentals of traffic operations at uninterrupted facilities, traffic signal control, and traffic flow theory.
2. Analyses of round-abouts unsignalised intersections, signal coordination etc.
3. Introduction to microscopic models and improve the knowledge in advanced theories of traffic flow.

Syllabus

Uninterrupted flow: Capacity and Level of service LOS, Urban Street, Multi lane high ways, Merging and diverging areas; gap acceptance, Corridor analysis, Problems in mixed traffic flow-case studies

Intersections-Analysis, Roundabouts- types and design - Uncontrolled intersection, Signalised intersection Co-ordinated traffic signal, Vehicle actuated signals and Area traffic control.

Traffic Flow Modelling, Traffic flow characteristics, various traffic stream models, Car following, acceleration noise. Traffic flow modelling analogies, Shock waves and bottleneck. Lane changing models, Flow models under mixed traffic. Simulation in Traffic Engineering

Expected Outcome

1. Understand the operation and analysis of uninterrupted facilities
2. Understand gap acceptance process, signal co-ordination
3. Understanding the various traffic flow models, flow along bottlenecks, shock wave phenomenon

References

1. Roess, Prassas, and McShane, Traffic Engineering, Pearson Prentice Hall, Fourth Edition, Upper Saddle River, NJ, 2011.
2. Pignataro, Louis J., Traffic Engineering, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, l983.
3. L. R. Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, NewDelhi.
4. Highway Capacity Manual, Transportation Research Board, Washington, D.C., 2010.
5. May, Adolf.D, Traffic Flow Fundamentals, Prentice Hall, Englewood Cliffs, N.J., 1990.
6. Gazis, DenosC.,Traffic Theory,KluwerAcademicPublishers,Norwell,MA,2002.
7. C.S.Papacostas, P.D.Prevedouros, Transportation Engineering and Planning, PHI Publication, 3rdedition, 2002.
8. Khisty C.J, Transportation Engineering-An introduction, Prentice Hall, NewJersey,1990.
9. CederA, Transportation and traffic theory, Pergamon Elsevier Science Ltd., Oxford.1999.
10. DaganzoC.F. Fundamentals of transportation and traffic operations, Pergamon, Elsevier Science Ltd, U.K., 1997.
11. Traffic Flow Theory: A State-of-the-ArtReport, TRB, Available free download athttp://www.tfhrc.gov/its/tft/tft.htm.
12. Traffic Theory, Denos C. Gazis, Springer, 2002.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Uninterrupted flow: Capacity and Level of service LOS: Definitions, highway capacity, factors affecting LOS, HCM methods; Urban Street: Classification, operational performance measures. Multilane highways: Characteristics, capacity and level of service.	6	15
II	Merging and diverging areas; gap acceptance, speed at ramps-Corridor analysis: Segment capacity, free flow travel time, queue delay	6	15
	FIRST INTERNAL EXAM		
III	Intersections- Analysis: Weaving sections: types, analysis. Roundabouts: introduction, types and design-Uncontrolled intersection: Gap acceptance studies, concept of critical gap, Gap acceptance models.	6	15
IV	Signalised intersection-Principles, fundamentals of signal timing and design. Co-ordinated traffic signal: Concepts of offset, common cycle length band width, offset for one-Wayand two-way streets-Vehicle actuated signals and Area traffic control: Basic principles.	8	15
	SECOND INTERNAL EXAM		
V	Traffic Flow Modelling: Traffic stream models: Traffic flow characteristics, Greenshield'smodel, Greenberg's logarithmic model, Underwood's exponential model, pipe's generalized model, multi-regime models; Car following, acceleration noise. Traffic flow modelling analogies: Fluid flow analogy, heat flow analogy, granular flow, Light hill- Withams theory, Boltzman like behaviour of traffic. Flow concepts including shock waves and bottleneck.	8	20
VI	Flow models under mixed traffic, Problems in mixed traffic flow – Case studies (Minimum 3 Indian studies). Introduction to simulation, Simulation in Traffic Engineering and its various components. Examples of simulation studies in traffic engineering stressing on VISSIM software	8	20
	END SEMESTER EXAM		

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6512	Analysis and Design of Intersections	**3-0-0**	**3**	**2015**

Course Objectives

1. To high light the basic principles of intersection design, operation and control.
2. To cover the capacity and performance analysis of various types of intersections.
3. To provide detailed knowledge about design of intersection controls.

Syllabus

Intersections: Types, Suitability, Principles of design, Design of speed change lanes and median lanes.

Analysis of Un-signalized Intersections: Capacity and LOS Concepts, Capacity and Performance Evaluation of TWSC and AWSC, Rotary Intersections, Mini Roundabout.

Design of Intersection Control and Performance Analysis of Signalized Intersection: Traffic signal design, Performance measures, Capacity, and LOS analysis of signalized intersections, General traffic control.

Expected Outcome

1. Design road junctions according to requirements/specifications
2. Carry out capacity and performance analysis of various types of intersections
3. Design of various types of intersection controls

References

1. Transportation Research Board, Highway Capacity Manual 2000, 2010
2. Roess, Prassas and McShane, "Traffic Engineering", Pearson Prentice Hall, Fourth Edition,UpperSaddleRiver,NewJersey2011
3. Garbeland Hoel, Traffic and Highway Engineering, Third Edition, Books/Cole Publishers
4. L. R. Kadiyali, Traffic Engineering and Transport Planning, Khanna publishers, NewDelhi
Relevant IRC codes

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Intersection-need and classification- General considerations for the location of various intersection types, principles of intersection design, factors affecting operation of intersection.	6	15
II	Types of intersections and their suitability, types of maneuvers, relative speed, conflict points and areas, design surveys for intersection, design of speed change lanes and median lanes.	6	15
FIRST INTERNAL EXAM			
III	Analysis of un-signalised intersections, roundabouts-Capacity and LOS Concepts of various types of at grade intersections – Capacity and performance evaluation of un-signalised intersections–TWSC and AWSC-Rotary Intersections-design and capacity analysis, Mini roundabout- design and analysis	8	15
IV	Design of intersection controls and performance analysis of signalised intersection Warrants for signals, Traffic signal design: Elements of traffic signal: Definitions, analysis of saturation headway, Saturation flow, lost time, critical flows, derivation of cycle length.	6	15
SECOND INTERNAL EXAM			
V	Design principles of a traffic signal: Phase design, cycle time determination, green splitting, pedestrian phases, and performance measures; Evaluation of a traffic signal: Definitions and measurement of stopped and control delay, Webster's delay model, over saturated conditions.	8	20
VI	Capacity and LOS analysis of signalized Intersection: HCM method of analysis of a signalised intersection and determination of the level of service. General traffic control by islands, pedestrian control, signs, markings, intersection lighting etc	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6514	Pavement Evaluation and Management	**3-0-0**	**3**	**2015**

Course Objectives

1. To understand the importance of pavement condition evaluation and prediction
2. To equip the students to understand various types of distresses, causes and remedies
3. To study the fundamentals and various levels of pavement management system the development of a Pavement Maintenance and Management System(PMMS)

Syllabus

- Structural and functional requirements of flexible and rigid pavements, Pavement Performance, Service ability concept, Pavement distresses
- Pavement Condition Survey, Estimation of PCI by Shahin's Deduct Value Method, Skid Resistance
- Characterisation of roughness, International Roughness Index(IRI), Structural evaluation by Non-Destructive Tests, Types– Benkelman Beam Deflection (BBD) measurement
- Falling Weight Deflectometer, Design of overlay using BBD data (IRC method), Destructive structural evaluation, Structural Capacity Index, Pavement performance prediction models
- Pavement Management System (PMS), Types of pavement Maintenance actions Pavement management levels: Network, Programme and Project level, Priority programming of maintenance and rehabilitation actions
- Life Cycle Cost Analysis, Heuristic Approach: Decision Matrix and Decision Tree, ToolsforPavementManagement:HDM-4,RoadEconomicsDecisionModel

Expected Outcome

1. Understand the importance of pavement condition evaluation and prediction in the proper maintenance of pavements
2. Understand the development of a Pavement Maintenance and Management System(PMMS)

References

1. Shahin M.Y, Pavement Management for Airports, Roads and Parking lots, Chapman & Hall, 2005.
2. Haas. R, Hudson. W. Zaniewsk John, Modern Pavement Management, Kreiger Publishing Company, 1994.
3. YangH Huang, Pavement Analysis and Design, Prentice Hall, 2004.
4. Latest revisions of IRC codes: IRC: 81 and IRC: 82

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Structural and functional requirements of flexible and rigid pavements, Pavement performance, Serviceability concept, Factors affecting pavement surface condition, Pavement distresses, Causes, Methods of measurement, Maintenance treatments	6	15
II	Pavement Condition Survey- Pavement Condition Index(PCI)–Estimation of PCI by Shahin's Deduct value method- Pavement surface condition: Skid resistance	6	15
FIRST INTERNAL EXAM			
III	Characterisation of roughness-Equipments for measuring roughness, profile indices, International Roughness Index(IRI), Factors affecting pavement structural condition, Structural evaluation by Non-Destructive Tests, Types–Benkelman Beam Deflection (BBD) measurement	8	15
IV	Falling Weight Deflectometer, Design of overlay using BBD data (IRC method), Destructive structural evaluation, Structural Capacity Index, Pavement performance prediction models: Mechanistic–Empirical, Regression, Stochastic, Static and Dynamic models	8	15
SECOND INTERNAL EXAM			
V	Pavement Management System (PMS): Concept, Objectives, Components of PMS, PMS functions, General Structure, Types of pavement Maintenance actions: Preventive and Corrective maintenance, Maintenance policy, Pavement management levels: Network, Programme and Project level, Priority programming of maintenance and rehabilitation actions	8	20
VI	Life Cycle Cost Analysis, Heuristic Approach: Decision Matrix and Decision Tree based on Economic Evaluation and Optimisation, Tools for Pavement Management: HDM-4, Road Economics Decision Model	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6516	Regional Transportation Planning	**3-0-0**	**3**	**2015**

Course Objectives

1. To equip the students with the basic concepts on theories of Regional Development and goods demand modelling
2. To understand the application of graph theory on transportation network analysis.
3. To understand Demographic and Employment Forecasting Models

Syllabus

Concept of region space, classification of region, theories of regional development- delineation of region- demographic models used in transportation planning- financial analysis- Economic Base Mechanism, Population and Employment multiplier models-Input and output models-Dynamic models inventory - Consumption and stock Piling Models – freight demand models-forecast of interzonal movements on the road network –Transportation Networks Structure and Applications of Graph Theoretical Concepts.

Expected Outcome

After successful completion of the course, students should make use of these theories and models for forecasting the goods demand and thus, national transportation planning

References

1. Hutchinson B. G Principles of Transportation System Planning, McGraw–Hill
2. Oppenheim N, Applied models in Urban and Regional Analysis, Prentice–Hall
3. Dickey. J. W; et.al; Metropolitan Transportation planning; Tata McGraw-Hill Wilson AG
4. Urban and regional models in Geography and Planning; John Wiley and Sons
5. Mishra R. P.et.al; Regional Development Planning in India, Vikas Publishing House, NewDelhi
6. HeggeiI G; Transportation Engineering Economics; Mc-Graw Hill Book Company, NewYork
7. IRC Journals 42-4, 44-1, 44-3 for Rural Road Network Planning

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Theories of Regional Development & Delineation of Transportation Planning Regions: Concept of region and space–Types of regions-Classification of Regions- Christaller's and Perouxian Theories of Regional Development-Delineation of Regions for Transportation Planning of a Nation.	**7**	**15**
II	Demographic and Employment Forecasting Models: Demographic models-Linear, Exponential and Logistic models, Cohort Survival models-Birth, Aging and Migration models, Employment Forecasting models-Economic Base Mechanism, Population and Employment multiplier models- Input and output models-Dynamic models of population and employment-Multi regional Extensions	**7**	**15**
FIRST INTERNAL EXAM			
III	Inventory of transportation sector—infrastructure-fleet—traffic parameters-revenues-energy use -collection of data-studies and plans relevant to nonurban transportation services-Estimating and Forecasting of Passenger and Goods Demand:	7	15
IV	Travel demand models- Mode Specific and Mode Abstract models, Programming model, Shift and Share model, Excess Production, Consumption and stockpiling Models, Models based on Behavioral Characteristic of Shippers- Model fitting-model calibration- measures of precision	**7**	**15**
SECOND INTERNAL EXAM			
V	Transportation Networks and Applications of Graph Theoretical Concepts: Directed Graph, Partial Graph, Sub-Graph, Complete Graph, Bi-Partite Graph, Chain, Cycle, Path sand Meshes, Cut sets, Trees and Arborescence, Spatial Measures of Output and spatial Attributes of Transportation System such as Accessibility, Comprehensiveness, Circuity and Connectivity of Transportation Network.	**7**	**20**
VI	Network Structure and Graph Theoretical indices such as Alpha, Beta and Gamma, Application of these concepts in Regional Transportation Planning	**7**	**20**
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6518	Intelligent Transportation System	**3-0-0**	**3**	**2015**

Course Objectives

1. To provide abroad exposure to ITS
2. To understand the relevance, technological applications and strategies using ITS
3. To understand there cent development and application process of ITS

Syllabus

Intelligent Transportation System: - needs, standards, system architecture and components of ITS. Development of ITS worldwide and Indian context and role of traffic management centres.

Various advanced traveller information systems available and data collection techniques to support ATIS. Application of ITS like Incident management and parking management, Electronic payment systems, Access control systems etc. ITS system design, sensor technologies, and positioning systems to support ITS applications. Automated Highway Systems: Evolution, trends, Integration, system configuration, Implementation, communication technologies and its impact on environment. Transportation planning and ITS, Emergency management systems and possibilities of ITS in India.

Expected Outcome

1. Understand the need for ITS and the sub sets of ITS.
2. To equip the students with practical case studies leading to ITS rather than conventional methods.

References

1. Joseph M. Sussman, Perspectives on Intelligent Transportation Systems, Springer2 005.
2. Bob Williams, Intelligent Transportation Systems Standards, Artech House 2008.
3. Sumit Ghosh and Tony.S.Lee, Intelligent Transportation Systems: Smart and GreenInfrastructureDesign,CRCpress,2010.
4. Mashrur A. Chowdhury and Adel Wadid Sadek Fundamentals of Intelligent Transportation Systems planning, Artech House, 2009.

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	History of ITS, ITS–Need, Standards and policy, System architecture, ITS Developments-Worldwide and Indian scenario, Metropolitan and Rural ITS. ITS user services: Traffic Management centers-Types and functions, Travel and traffic management, Public transportation operations, Commercial vehicle operations.	8	15
II	Advanced Traveller Information systems:-Pre-trip and Enroute information, Data collection techniques, Route Guidance Systems, Infrastructure based systems and its applications, Variable message signs, Vehicle to Center and Vehicle to Road side communication.	6	15
FIRST INTERNAL EXAM			
III	Application of ITS: Incident Management-, Parking management, Electronic payments, Electronic toll collection systems, Access controls: Ramp metering, Dynamic speed adaptation. Advanced traffic control systems, In-vehicle systems. Dynamic routing/scheduling.	8	15
IV	ITS Design: ITS system design- components and requirements, ITS for road network-System Design-Sensor technologies and data requirements for ITS. Positioning systems in ITS, GPS and Mobile phone locations and its potential on ITS applications. Telecommunication in ITS, Integration of GPS and GIS for ITS.	6	15
SECOND INTERNAL EXAM			
V	Automated Highway Systems: Evolution of AHS and new trends, Smart cars, Vehicle in platoons, Integration of AHS, System configuration, Implementation of AHS, Communication technologies for AHS, Control and sensor requirements in AHS, Effect of AHS on Environment.	8	20
VI	Transportation planning and ITS: - Relationships between problems, conventional approach and ITS approach. (Case studies), Operations and fleet management, Emergency management systems, Collision warning systems. Possibilities of ITS in India and Future of ITS.	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6622	Geoinformatics in Transportation Engineering	**3-0-0**	**3**	**2015**

Course Objectives

1. To understand the basic concepts of Geoinformatics in the context of transportation and transportation networks.
2. To learn the data needs and database development for doing transportation analysis in GIS environment.
3. To understand the concepts of transportation networks and algorithms and how they are incorporated into GIS.

Syllabus

Traffic Engineering Studies and Analysis: Sampling in traffic studies, Origin – destination, Parking. Concept of PCU, Types of manoeuvres and conflict points. Transportation Planning using GIS, Traffic Analysis Zone (TAZ) and screen lines, Four Stage Planning Process (Brief description only), Network representation of a transportation System

ITS: Introduction to Intelligent Transport System, Public Transportation Management System, Application of GIS in vehicle routing analysis and visualisations of traffic data in GIS, Travel time analysis using GPS-GIS integration. GIS-T applications: Scope of TransCAD and EMME in Transportation Planning (Introduction only)

Expected Outcome

1. Students will acquire a basic understanding of how GIS processes can be used for efficient transportation modeling and analysis.
2. Students will understand various applications of GIS in Transportation (GIS-T) including Intelligent Transport Systems (ITS)

References

1. Hensher D. A., Button K. J., Haynes K. E., and Stopher P. R. (Eds.), Handbook of Transport Geography and Spatial Systems", Elsevier,2004.
2. Thill Jean-Claude, Geographical Information Systems in Transportation Research, Pergamon, 2000.
3. Longley P. A., Barnsley M. J., Donnay Jean-Paul, Remote Sensing and Urban Analysis, Taylor & Francis, 2001.
4. Caliper Corporation, Travel Demand Modelling with TransCAD, 2009.
5. Hutchinson, B. G., Principles of Urban Transportation Planning, Mc Graw Hill, 1979
6. Kadiyali L.R, Traffic Engineering and Transportation Planning, Khanna Publishers

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Traffic Engineering Studies and Analysis: Objectives, Sampling in traffic studies, sample size; Data collection, analysis and interpretation -Spot speed, Speed and delay, Volume, Origin – destination, Parking.	**7**	15
II	Concept of PCU, Factors affecting capacity and level of service, Types of manoeuvres and conflict points	**7**	15
FIRST INTERNAL EXAM			
III	Transportation Planning using GIS- Travel Demand Estimation- Application of GIS, Traffic Analysis Zone (TAZ) and screen lines, Four Stage Planning Process (Brief description only),	**7**	15
IV	Network representation of a transportation System, Shortest Path determination, GIS based Transportation Planning, Spatial and Non spatial data for land use and transportation.	**7**	15
SECOND INTERNAL EXAM			
V	ITS: Introduction to Intelligent Transport System- Components of ITS, Application of ITS to Traffic Management System- Public Transportation Management System, Application of GIS in vehicle routing analysis and visualisations of traffic data in GIS.	**7**	20
VI	Integration of GPS and GIS, Travel time analysis using GPS-GIS integration. GIS-T applications: Scope of TransCAD and EMME in Transportation Planning (Introduction only)	**7**	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6522	Sustainable Transportation	**3-0-0**	**3**	**2015**

Course Objectives

1. Understanding the importance and principles of sustainability
2. Understanding sustainable planning
3. Understanding sustainable design
4. Ability to analyse sustainable solutions for transport problems

Syllabus

Introduction to the concept of sustainability, basic principles, sustainable transportation planning, land use and travel behaviours, networks, automobile dependence and impacts, design for sustainable transportation, vulnerable road users, professional praxis and paradigm shift, innovations, case studies, emerging concepts, congestion and pollution management, sustainability through public transport.

Expected Outcome

1. Propose plans for sustainable development in transportation sector.
2. Application of principle of sustainability in projects
3. Understanding green technology

References

1. McClintock, H. Planning for Cycling – principles, practice and solutions for urban planners. Cambridge: CRC Press.
2. Frumkin, H.; Frank, L. and Jackson, R. Urban Sprawl and Public Health, designing, planning, and building for healthy communities. Washington DC: Island Press.
3. Newman, P. and Kenworthy, J. Sustainability and Cities – Overcoming Automobile Dependence. Washington DC: Island Press.

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Introduction: Sustainable transportation, definition, necessity, fundamental principles, quantifying sustainability. Sustainable transportation planning: land use and travel behavior;	6	15
II	Sustainable Transportation Networks; built environment and public health; transportation demand management; automobile dependence and oil consumption; the transportation needs of special populations (elderly, children, disabled and immigrants).	6	15
FIRST INTERNAL EXAM			
III	Design for Sustainable Transportation: design of bicycle and pedestrian facilities; safety issues for pedestrians and bicyclists; Bicycle and pedestrian planning.	8	15
IV	Professional praxis; principles of applying professional praxis under a state of paradigm shift. Retro fitting existing urban areas; Innovative transportation solutions, case studies. Paradigm shift in planning	8	15
SECOND INTERNAL EXAM			
V	Emerging concepts in sustainable transportation: green vehicles and green roads, green and alternate fuels; managing congestion: car-sharing, pricing control: congestion and emission pricing.	8	20
VI	Sustainable public transport: promoting public transport: principles involved and techniques, miscellaneous transportation systems, integrated public transport systems.	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6592	Mini Project	**0-0-4**	**2**	**2015**

Course Objectives

To make students

Design and develop a system or application in the area of their specialization.

Approach

The student shall present two seminars and submit a report. The first seminar shall highlight the topic, objectives, methodology, design and expected results. The second seminar is the presentation of the work / hardware implementation.

Expected Outcome

Upon successful completion of the mini project, the student should be able to

1. Identify and solve various problems associated with designing and implementing a system or application.
2. Test the designed system or application.

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6594	Pavement Materials and Evaluation Lab	**0-0-2**	**1**	**2015**

Course Objectives

1.To introduce the practical problems on traffic engineering and road safety
2.To introduce the analysis softwares
3.To introduce the transportation planning softwares

LISTOFEXPERIMENTS

A. Test on aggregates

1. Aggregate impact test
2. Los Angeles abrasion test
3. Shape test
4. Stripping value

B. **Test on bitumen**

1. Viscosity test
2. Softening point test
3. Ductility test
4. Test on bitumen emulsion and cut back bitumen

C. Test on bituminous Mixes

1. Marshall Mix design and stability test
2. Indirect tensile strength test
3. Rut wheel test
4. Preparation and test on cold mixes
5. Bitumen extraction test

D Pavement evaluation

1. Roughness measurement using Roughometer and MERLIN
2. Benkelman beam deflection studies and Analysis

Expected Outcome

1.Knowledgeonanalysingandsolvingtrafficengineeringproblems
2.Abilitytoworkwithtransportationplanningsoftwares
3.Abilitytoconduct road safety audits

COURSE PLAN

Expt. no:	Title	Hours Allotted
A.	**Test on aggregates**	
	1. Aggregate impact test	1
	2. Los Angeles abrasion test	1
	3. Shape test	2
	4. Stripping value	1
B.	**Test on bitumen**	
	5. Viscosity test	1
	6. Softening point test	1
	7. Ductility test	1
	8. Test on bitumen emulsion and cut back bitumen	2
C.	**Test on bituminous Mixes**	
	9.Marshall Mix design and stability test	4
	10.Indirect tensile strength test	2
	11. Rut wheel test	2
	12.Preparation and test on cold mixes	2
	13.Bitumen extraction test	2
D.	**Pavement evaluation** 14.Roughness measurement using Roughometer and MERLIN	6
	15. Benkelman beam deflection studies and Analysis	6

SEMESTER – III

Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7511	Traffic Simulation Modelling and Applications	**3-0-0**	**3**	**2015**

Course Objectives

1. To introduce students to the concepts, techniques and applied aspects of the development of simulation models.
2. Introduction to different types of simulation, methods of random number generation, random number testing, and generation of random variates.
3. An overview of queuing models and introduction to the various steps involved in development of traffic simulation models under heterogeneous condition.
4. Introduction to discrete simulation models like cellular automata.

Syllabus

Statistical models in Simulation and Overview of Probability & Statistics
Random Number Generation: Properties, Techniques & various Tests
Random Variate Generation: Various Techniques and Methods for Generation
Queueing Theory & Models: Concepts & Characteristics of Queueing Systems
Simulation in Traffic Engineering: Application of traffic simulation models
Simulation of Queueing models: Discrete simulation models, Cellular Automata

Expected Outcome

1. Understand the basic principles of simulation;
2. Understand the structure of different approaches and types of traffic simulation models And the underlying assumptions that govern their behaviour;
3. Identifyapplicationsforwhichsimulationistheappropriatemodelforuse.

References

1. Law, Averill, Kelton, W. David, Simulation Modeling and Analysis, McGraw Hill Higher Education.
2. Deo, Narasingh, System Simulation by Digital Computer, Prentice Hall India.
3. Drew, D.R., Traffic Flow Theory and Control, McGraw Hill
4. May A. D., Traffic Flow Fundamentals, Prentice Hall
5. S. M. Ross, Simulation, 4th edition, Elsevier, 2006
6. R. Dowling, A. Skabardonis, and V. Alexiadis, Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software, FHWA-HRT-04-040.
7. R. Roess, E. Prassas, and W. McShane, Traffic Engineering, 3rd edition, Prentice Hall, 2004.
8. S. Washington, M. Karlaftis, and F. Mannering, Statistical and Econometric Methods for
9. Transportation Data Analysis, Chapman & Hall/CRC, 2003.
10. S. Ólafsson (2006). Metaheuristics," in B.L. Nelson and S. Henderson (eds.). Handbook on Simulation, Handbooks in Operations Research and Management Science VII, Elsevier, 633-654.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Introduction- Definitions, advantages and disadvantages, different types, simulation languages-Statistical models in simulation- Overview of probability and statistics, useful statistical model, discrete distribution, continuous distribution.	6	15
II	Monte Carlo techniques, stochastic simulations - Random Number Generation: Properties of random numbers, generation of true and pseudo random numbers, techniques for generating random numbers, hypothesis testing, various tests for uniformity (Kolmogorov-Smirnov and Chi-Square) and independence (runs, autocorrelation, gap, poker).	6	15
FIRST INTERNAL EXAM			
III	Random Variate Generation: Different techniques to generate random variate:- inverse transform technique, direct transformation technique, convolution method and acceptance rejection techniques, algorithms for generation of random variates for different distributions used in traffic engineering.	8	15
IV	Queueing Models: Queueing theory concepts, characteristics of queueing systems, queueing notations, measures of performance of queueing systems, Steady state behaviour of Markovian models (M/G/1, M/M/1, M/M/c)	8	15
SECOND INTERNAL EXAM			
V	Simulation in Traffic Engineering: Application of traffic simulation models for analysis of dynamic traffic systems and design: input data preparation, calibration, validation, analysis of output. Models for vehicle arrival and related models for development of complete simulation models for mid-block and intersections under homogenous and mixed traffic.	8	20
VI	Simulation of queueing models- Discrete simulation models: Cellular automata concepts, discretization of time and space, rules for acceleration, deceleration, randomization, and vehicle updation, simple examples from traffic engineering.	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7513	Advanced Travel Demand Modelling	**3-0-0**	**3**	**2015**

Course Objectives

1. To introduce the forecasting techniques
2. To introduce the theories on individual choice behaviour
3. To introduce the process of conducting choice survey
4. To understand about model aggregation and transferability of a developed model

Syllabus

Direct demand models, Discrete choice models- methods, Specification and estimation of discrete choice models, Design of Surveys, Modelling with SP choice data; Experimental design, Model Aggregation and Transferability, Simplified Transport Demand Models- estimation from traffic counts, Freight demand modeling, Activity based modeling

Expected Outcome

1. Knowledge on forecasting techniques and travel choice behaviour
2. Ability to design a survey questionnaire based on the objective of survey
3. Knowledge on model aggregation, updating and transferability

References

1. Orturzar,J.deD.andL.G.Willumsen(2011)ModellingTransport,WileyPublishers
2. OppenheimN(1995)UrbanTravelDemandModelling:FromIndividualChoicestogeneralequilibrium.JohnWiley&sons,Inc
3. TimeuseAnalysis,SpecialIssue,Transportation,26,KluwerAcademicPublishers
4. Michael Florian (2000), Economics & Mathematical Systems: Traffic Equilibrium Methods.
5. Ben Akiva (1985)Discrete Choice Analysis: Theory and Application to Travel Demand, MIT Press
4. OrturzarJ. deD(2000) Stated Preference Modelling Techniques, PTRC Education and Research Services
5. Jordan J. Louviere, David A. Hensher, Joffre D. Swait (2000), Stated Choice Methods: Analysis and Applications

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Direct demand models, Discrete choice models- multinomial logit model, hierarchical logit model, multinomial probit model	6	15
II	Specification and estimation of discrete choice models- determination of choice set, functional form, statistical estimation, validation	6	15
FIRST INTERNAL EXAM			
III	DesignofSurveys:Statedpreferencevs.RevealedPreferences;Fundamentalsof stated preference- stages in data collection, identification of preferences, ranking, rating and choice,	8	15
IV	Modelling with SP choice data; experimental design, Role of Soft variables in Travel Demand Forecasting, Basic Rating Scales, Discrete choice modelling with rating, ranking and choice data, modelling with mixed RP and SP data.	6	15
SECOND INTERNAL EXAM			
V	Model Aggregation and Transferability: Aggregation bias and forecasting; Aggregation Methods; Model Updating or Transference-Transfer Model, Updating Procedures–Transferring with aggregate and disaggregate sample data; Transferability Measures.	8	20
VI	Simplified Transport Demand Models: Sketch planning Methods; Incremental Demand Models; Model estimation from traffic Counts, Freight demand modeling, Activity based modeling.	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7515	Public Transportation System	**3-0-0**	**3**	**2015**

Course Objectives

1. To introduce the importance of Public Transportation and its planning concept
2. To understand the components of Transit operations and its pricing
3. For planning transit route network based on the passenger demand

Syllabus

Transit Operations: Basic operating elements of public transit, Data requirements and collection techniques, Frequency and Headway distributions, Scheduling of service and timetable development, Transit Line Capacity, Level of Service measures, Transit System Statistics, Route choice and assignment, Modelling and Optimization in Transit Systems Analysis, Transit Lines and Networks, Stopping policy and stopping regimes, planning of rail transit station location

Expected Outcome

1. Awareness of the essentiality top remote Public Transit Units
2. To undertake planning activities connected with Transit operations.
3. To plan and prepare transit routes and schedules and the transit fares.

References

1. Ceder, Avishai (2007), Public Transit Planning and Operation: Theory, Modelling and Practice, Butterworth- Heinemann, Elsevier, Oxford, UK.
2. White, Peter (2008), Public Transport: Its Planning, Management and Operation, Taylor & Francis, London.
3. Vuchic, Vukan. R (2005), Urban Transit: Operations, Planning and Economics, Wiley, New Jersy.
4. Khisty, CJ. (2002), Transportation Engineering–An Introduction, Prentice-Hall, New Jersy.
5. Partha Chakroborty, Principles of Transportation Engineering, Animesh Das, Prentice-Hall, India.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Transit Operations: Basic operating elements of public transit, Public transport travel characteristics, Transit travel characteristics: factors, spatial distribution, temporal variations, Introduction to transit service planning, Operational planning process, Service and evaluation standards.	6	15
II	Data requirements and collection techniques, Frequency and Headway distributions: Determination of good route set, Scheduling of service and timetable development: optimum headway and fleet allocation, Introduction to Crew scheduling and rostering.	8	15
FIRST INTERNAL EXAM			
III	Transit Line Capacity: Elements and Computation, Systems approach to transit line capacity, Capacities of different modes, Level of Service measures, Passenger demand: factors and elasticity, Passenger volume analysis and service capacity determination	6	15

IV	Transit System Statistics, Route choice and assignment, Modelling and Optimization in Transit Systems Analysis: Application, Conceptual and Mathematical modelling, Applications of simulation methodology.	6	15
SECOND INTERNAL EXAM			
V	Transit Lines and Networks: Planning objectives, principles and considerations, Geometry of transit lines, Types of transit lines and their characteristics, Transfers in transit networks, Transit network types and characteristics, Analysis of metro network geometric forms,	8	20
VI	Stopping policy and stopping regimes: Determination of optimum stops. Planning of rail transit station location: Integration of objectives, station spacing. Modern Approaches in Transit planning: Information System for Passengers, Application of ITS.	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7517	Analytical Techniques in Transportation Planning	**3-0-0**	**3**	**2015**

Course Objectives

1. To study about various data analysis techniques viz; multivariate data analysis and network flow theory
2. To study about the concept of econometric models
3. To know about the application of these techniques in transportation problems

Syllabus

Multivariate data analysis techniques: data, estimation of centroid, standard deviation, factor analysis, cross classification procedure, applications

Network Flow Theory: Basic Concepts and definitions forward and reverse star representations, Network transformations, applications

Econometric Models: Latent Variable Models, Structural Equation modeling, duration models, discrete outcome models

Expected Outcome

1. Understand multivariate data analysis technique
2. Understand the concept of network flow theory and econometric models
3. Able to apply these techniques in transportation problems

References

1. Ravindra K. Ahuja, Thomas L. Magnanti, James B. Orlin. Network *Flows Theory, Algorithms and Applications*, Prentice Hall, New Jersey.
2. Juan de Dlos Ortuzar and Luls G. Willumsen. *Modelling transport*, John Wiley and Sons
3. Kalyanmoy Deb. *Muliti-Objective using Evolutionary Algorithms*, John Wiley and Sons Ltd.
4. Simon P., Mathew G. Karalftis, Fred L. Mannering. *Statistical and Econometric Methods for Transportation Data Analysis*, CRC Press LLC, Florida
5. Cooley, W. W. And Lohnes, R. R. *Multivariate Data Analysis.*
6. Wilson, A. G. *Entropy in Urban and Regional Modelling*, Pion, London.
7. Kanafani, A. *Transportation Demand Analysis*, McGraw – Hill.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Types of data, basic vectors and matrices, Sample Estimation of Centroid, Standard deviation, Dispersion, Variance and Covariance, Correlation matrices,	6	15
II	Principle component, Factor Analysis, Cluster Analysis, Cross Classification procedure in Multivariate data analysis, Application to problems in traffic and Transportation Planning	6	15
FIRST INTERNAL EXAM			
III	Basic Concepts and definitions – directed and undirected graphs-node-links-trees-path-cycles-connectivity – cut, network representation - Node-arc incidence Matrix, Node-Node adjacency Matrix- adjacency Lists- forward and reverse star representations-.	8	15
IV	Network transformations- berth and search algorithms- formulation of shortest path problem- maximum flow problem- minimum cost flow problem- algorithm- applications in transportation network problem	8	15
SECOND INTERNAL EXAM			
V	Latent Variable Models – Structural Equation modelling – Duration models – Hazard based duration models – Non parametric, semi parametric and fully parametric models –	8	20
VI	Discrete outcome models – Multinomial Logit Models – Nested Logic Models – Discrete Continuous models (Overview Only)	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7519	Applications of Geo-Synthetics in Pavements	**3-0-0**	**3**	**2015**

Course Objectives

Introduction of various type of geotextiles and functions

1. Various properties and testing of geotextiles
2. Identify potential areas of application in pavements, how it is applicable and its design

Syllabus

Introduction to Geotextiles: Types, Manufacturing Methods, Functions,.
Natural Geotextiles: Jute, Coir, Bamboo, Combination of Geotextiles
Basic Properties: Physical, Mechanical, Hydraulic, Constructabililty, Durability
Testing and Evaluation: Test Condition, Sampling, Testing Methods
Pavement Applications: Giroud and Noiray approach, Crack Control, Uses in paved roads
Applications: Filtration and Drainage, Embankments, Retaining walls, Rigid and Flexible pavements, AASHTO design

Expected Outcome

1. Understand various types of geo synthetics
2. Understand potential areas of application of geotextiles, its testing standards.
3. Acquire capability for selection, design of geo synthetics for various applications.

References

1. Koerner, R.M. Designing with Geo synthetics, Prentice Hall, New Jersey, USA, 4th edition, 1999.
2. G.V. Rao, PK Banerjee, J.T. Shahu, G.V. Ramana. Geo synthetics - New Horizons, Asian Books Private Ltd., New Delhi, 2004.
3. G. Venkatappa Rao, Geo synthetics-An Introduction, Sai Master Geo environmental Services Pvt Ltd., Hyderabad, 2011.
4. G. Venkatappa Rao & Goutam K. Pothal, Geo synthetics Testing-A Laboratory Manual, Sai Master Geo environmental Services Pvt Ltd., Hyderabad, 2008.
5. Rao G.V. & Rao G.V.S., "Text Book On Engineering With Geotextiles", Tata McGraw hill
6. . Rao G.V & Balan. K, Coir Geotextiles-emerging trends (2002), Kerala state coir corporation Alappuzha.
7. Gerard P.T.M. Van Santvrot, A.A. Balkema, Geotextiles and Geomembranes in Civil Engg." Oxford and IBH publishing company, New Delhi.
8. J.N. Mandal, "Geo synthetics World", Willey Eastern Ltd., New Delhi.
9. G.L Siva Kumar Babu, "An Introduction to Soil Reinforcement and Geo synthetics", university press(India) private limited hyderabad,2006

COURSE PLAN

Module	Contents	Hours Allotted	Marks in End-Semester Examinat
I	Geotextiles-overview, introduction, types including natural geotextiles, manufacturing methods, Functions of Geotextiles- fluid transmission, filtration, separation, protection, Sediment Control, Reinforcement,design principles and influencing factors	6	15
II	Natural Geotextiles- factors governing the usage of natural geotextiles, Types and applications- jute fibres, coir geotextiles, bamboo/timber, combination of geotextiles	6	15
FIRST INTERNAL EXAM			
III	Basic Properties- physical(Mass per unit area, thickness, compressibility, apparent opening size, width and length), mechanical(Tensile strength, narrow strip tensile test, grab test, strip and wide width tensile test, seam testing, interface friction, creep resistance), hydraulic, constructability/survivability (puncture test, CBR push through test, trapezoidal tear test, diaphragm bursting strength test, cone drop test), durability (abrasion resistance, ultra-violet resistance, temperature stability, chemical stability)	8	15
IV	Testing and Evaluation- importance of testing, test conditions, sampling, testing methods- Techniques for testing of different index properties, strength properties, Apparent Opening Size, In-plane and cross-plane permeability tests, assessment of construction induced damage, extrapolation of long term strength properties from short term tests.	8	15
SECOND INTERNAL EXAM			
V	Pavement Applications- Paved Surface Rehabilitation, Reflective Crack Treatment for Pavements, Geotextiles for separation and reinforcement in flexible pavements, design by Giroud-Noiray, improvement of bearing capacity using geotextiles Use of geotextiles for construction of heavy container yards and railway lines. Applications in Bituminous Pavements- Model study on Geotextile Reinforced Asphaltic Concrete	8	20
VI	Applications- Filtration and Drainage: geotextile filter requirements, drain and filter properties, design criteria; Embankments in soft soil: stability analysis, influence of reinforcement extensibility, relationships for design, settlement analysis; soil retaining walls: components, principles of design; Reinforcement design applications in rigid and flexible pavements, AASHTO design criteria; construction methods	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7521	Advanced Optimisation Techniques for Transportation Engineering	**3-0-0**	**3**	**2015**

Course Objectives

1. Aims at introducing use of quantitative methods and techniques for effective decisions – making; model formulation and applications that are used in solving decision making problems related to transportation engineering.
2. Proficiency with tools in optimization including fundamental applications of these tools in contexts involving uncertainty and scarce or expensive resources.

Syllabus

Conceptofuncertainty-Markovanalysis–stochasticrandomprocess-transitionprobability-Markovchain-steadystate condition.

Characteristicsofdynamicprogramming.Dynamicprogrammingapproachapplicationsintrafficandpavementmanagement.

Game theory, Dominance Method and graphical method for solving mixed strategy game.

Replacement Models, deterioratingitemswithincreasingmaintenancecostandconstantmoneyvalue-Itemsthatfailsuddenly-Replacementpolicy.

Fundamentals of network flow theory, Network representation- Minimalspanningtreealgorithm-shortestrouteproblems-Maximumflowmodel-linearprogramming, formulation of CPM-PERT Network.

Time series models: Forecastingmodels-introductiontotimeseriesmodels-characteristicsmomentsinatimeseries-measurementoftrends-ARMA-ARIMA

Expected Outcome

1. To attain fluency with mathematical and computational modeling of real decision-making problems,
2. To introduce the use of modeling tools and computational tools and analytic skills to evaluate the problems

References

1. J.K. Sharma., Operations Research Theory & Applications, 3e, Macmillan India Ltd, 2007.
2. P. K. Gupta and D.S. Hira, Operations Research, S. Chand & co., 2007.
3. J K Sharma., "Operations Research, Problems and Solutions,3e",MacmillanIndiaLtd.
4. N. V. S. Raju, "Operations Research", HI-TECH, 2002.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Probability and statistical analysis for management decisions Concept of uncertainty-Markov analysis–stochastic random process-transition probability-Markov chain-steady state condition.	6	15
II	Dynamic programming and reliability Characteristics of dynamic programming. Dynamic programming approach applications in traffic and pavement management-smoothening, capital budgeting, Stage Coach/Shortest Path, and Reliability problems-formulation	8	15
	FIRST INTERNAL EXAM		
III	Basics of Game theory Concept-Two person zero-sum game-pure and mixed strategy-Games-saddle point-Odds method-Dominance Method and graphical method for solving mixed strategy game.	6	15
IV	Replacement Models - Deteriorating items with increasing maintenance cost and constant money value – Items that fail suddenly –Replacement policy: individual and group	8	15
	SECOND INTERNAL EXAM		
V	Fundamentals of network flow theory Network representation- Minimal spanning tree algorithm-shortest route problems-Maximum flow model-linear programming-excel spreadsheet solution of maximum flow model-minimum cost capacitated flow problems- formulation (LPP)-capacitated network simplex algorithm-LPP formulation of CPM-PERT Network.	8	20
VI	Time series models: Forecasting models-introduction to time series models-characteristics moments in a time series-measurement of trends-ARMA-ARIMA	6	20
	END SEMESTER EXAM		

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7591	Seminar II	**0-0-2**	**2**	**2015**

Course Objectives

To make students

1. Identify the current topics in the specific stream.
2. Collect the recent publications related to the identified topics.
3. Do a detailed study of a selected topic based on current journals, published papers and books.
4. Present a seminar on the selected topic on which a detailed study has been done.
5. Improve the writing and presentation skills.

Approach

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

Expected Outcome

Upon successful completion of the seminar, the student should be able to

1. Get good exposure in the current topics in the specific stream.
2. Improve the writing and presentation skills.
3. Explore domains of interest so as to pursue the course project.

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7593	Project (Phase I)	**0-0-12**	**6**	**2015**

Course Objectives

To make students

1. Do an original and independent study on the area of specialization.
2. Explore in depth a subject of his/her own choice.
3. Start the preliminary background studies towards the project by conducting literature survey in the relevant field.
4. Broadly identify the area of the project work, familiarize with the tools required for the design and analysis of the project.
5. Plan the experimental platform, if any, required for project work.

Approach

The student has to present two seminars and submit an interim Project report. The first seminar would highlight the topic, objectives, methodology and expected results. The first seminar shall be conducted in the first half of this semester. The second seminar is the presentation of the interim project report of the work completed and scope of the work which has to be accomplished in the fourth semester.

Expected Outcome

Upon successful completion of the project phase 1, the student should be able to

1. Identify the topic, objectives and methodology to carry out the project.
2. Finalize the project plan for their course project.

SEMESTER – IV

Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7594	Project (Phase II)	**0-0-21**	**12**	**2015**

Course Objectives

To continue and complete the project work identified in project phase 1.

Approach

There shall be two seminars (amid term evaluation on the progress of the work and pre submission seminar to assess the quality and quantum of the work). At least one technical paper has to be prepared for possible publication in journals / conferences based on their project work.

Expected Outcome

Upon successful completion of the project phase II, the student should be able to

1. Get a good exposure to a domain of interest.
2. Get a good domain and experience to pursue future research activities.