SCHEME AND SYLLABUS
OF
M.Tech Programme in
Civil Engineering
( 2013 Scheme )
with specialisation in
TRAFFIC AND TRANSPORTATION
ENGINEERING

University of Kerala
Thiruvananthapuram
<table>
<thead>
<tr>
<th>Code No.</th>
<th>Name of Subject</th>
<th>Credits</th>
<th>Hrs / week</th>
<th>End Sem Exam hours</th>
<th>Marks</th>
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<td>CMA 1002</td>
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Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End sem exam is conducted by the University.
*Students can select a subject from the subject listed under stream/department electives as advised by the course coordinator.

<table>
<thead>
<tr>
<th>Stream Electives I</th>
<th>Stream Electives II</th>
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<tbody>
<tr>
<td>CTE 2001 Analytical Techniques in Transportation Planning</td>
<td>CTE 2004 Traffic Simulation Modelling and Applications</td>
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<tr>
<td>CTE 2002 Analysis and design of Intersection</td>
<td>CTE 2005 Highway design and Safety</td>
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<td>CTE 2003 Intelligent Transportation System</td>
<td>CTE 2006 Operations Research</td>
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<td>Non- Dept. (Interdisciplinary) Elective</td>
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**Stream Elective III**
- CTE3001  Project Management
- CTE3002  Advanced Travel Demand Modelling
- CTE3003  Sustainable Transportation

**Stream Elective IV**
- CTE3004  Public Transportation System
- CTE3005  Application of Geo-Synthetics in pavements
- CTE3006  Advanced Optimisation Techniques for Transportation Engineering
<table>
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<th>Code No</th>
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List of Department Electives

1. CSD 2001 Design of Bridges
2. CHD 2001 Project Planning in Water Resources
3. CRD 2001 Geoinformatics in Civil Engineering
   (Students of Geoinformatics specialization are not allowed to choose CRD 2001 subject as the contents are dealt with in detail in the core papers)
4. CGD2001-Geoenvironment and landfill
5. CGD2003-Geoenvironment and landfill
7. CTD 2002 Regional Transportation Planning
8. CED 2001 Ecological Engineering
9. CED 2002 Air Pollution Control and Monitoring
10. CED 2003 Environmental Impact Assessment and Risk Analysis

List of Interdisciplinary Electives

1. CSI 3001 Finite Element Analysis
2. CSI 3002 Mechanics Of Composites
3. CHI 3001 Fuzzy Sets And Systems In Engineering
4. CRI 3001 Geoinformatics For Infrastructure Development
5. CGI 3001 Geotechnical Engineering For Infrastructure Projects
6. CTI 3001 Fundamentals Of Reliability Engineering
7. CEI 3001 philosophy Of Technology
8. CEI 3002 Environmental Management
9. CEI 3003 Environment And Pollution
CMA 1002                          Applied Probability and Statistics

Structure of the Course
Lecture: 3 hrs/ Week           Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination      : 60 Marks

Course Objectives
• To teach about the probability and random variable of the various functions
• To understand statistical procedures for data analysis

Learning Outcomes
• To equip the students to make use of the statistical procedures in the modelling of data in their field of study.

Module I
Probability Distributions: Probability mass functions and probability density function, mean and variance. Binomial, Poisson, Exponential, Gamma, Lognormal and Normal distribution, Fitting of the distributions (brief overview only).
Sampling Techniques: Simple random sampling, Stratified sampling, Systematic sampling, Sample size determination-application
Statistical Inference: Intervals estimation, Confidence interval for mean, variance and regression coefficients. Sampling distribution, test of significance of (i) Mean (ii) Mean of two samples (iii)Proportions (iv) Variance (v) Two variance (vi) Two observed correlation coefficients(Fishers’ z-transformation) (vii) Paired T-test (viii) Regression coefficients (ix) Chi-square test of goodness of fit, Skewness and Kurtosis tests.

Module II
Regression and Correlation: Linear regression and correlation, multiple correlations, multiple correlation co-efficient, standard error of estimate, curvilinear regression-applications Analysis of variance (i) Completely randomized designs (ii) Randomized block designs. Latin Squares, Grecco Latin square designs, Factorial experiments, Graphical presentation techniques.

Module III
Multivariate Analysis: Co-variance matrix- correlation matrix-multivariate normal density function-principal components- sample variation by principal components-principal components by graphs

References

Structure of the Question paper
There will be three questions from each module out of which two questions are to be answered by the students.
CTC 1001 Transportation Economics and Appraisal

Structure of the Course
- Lecture: 3 hrs/Week  Credits: 3
- Internal Continuous Assessment: 40 Marks
- End Semester Examination: 60 Marks

Course Objectives
- To provide broad insight into the different facets of transportation systems.
- To provide solid introduction to transportation demand and cost analyses.
- Identification of various costs and benefits associated with highway construction, fare policy for bus transit, pricing theory, congestion pricing etc.
- To introduce the various compound interest equations and various methods of economic analysis.
- Introduction to the econometrics of industrial location, various stages of project appraisal and preparation of feasibility report are covered.
- Introduction to the economics evaluation of few mass transit projects.

Learning Outcomes
- Understand the principle of economics and its application in transportation
- Understand the benefits and costs associated with various transport projects and its monetary evaluation
- Familiarisation with the application of various methods of economic analysis and their comparison.

Module 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, 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

Module II
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, Indirect costs and benefits of transportation projects, Comparison of various methods, case studies and problems.

Module III

Economic evaluation of mass transit projects.

References:
3. L.R. Kadiyali ‘Traffic Engineering and Transport Planning’
4. Fair and Williams 'Economics of Transportation'
5. Herbert Mohring ‘Transportation Economics’
7. Dominick Sabatore - Schaum's Outline series ‘Theory and problems of micro economic theory’
8. Winfrey- Transport Economics
10. Dr. Vinay Maitri Dr. P.K. Sarkar, Theory & Applications of Economics in Highway & Transport Planning, Standard Publishers and Distributors

**Structure of the Question paper**

For the end semester Examination the question paper will consists of three questions from each module out of which two questions are to be answered by the students.
CTC 1002    Urban Transportation Planning

Structure of the Course

Lecture: 3 hrs/ Week                Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination         : 60 Marks

Course Objectives

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

Learning Outcomes

- Understand the various transportation planning concepts
- Understand four step modelling concept in Urban Transportation Planning
- Familiarise the mathematical travel demand model development concepts and its solutions

Module 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. 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.

Module II


Module III


Reference

5. Partha Chakroborty,Principles of Transportation Engineering,Animesh DasPrentice-Hall, India.

Structure of the Question paper

For the end semester Examination the question paper will consists of three questions from each module out of which two questions are to be answered by the students.
CTC 1003 Analysis and Design of Pavement Systems

Structure of the Course
Lecture: 3 hrs/ Week Credits : 3
Internal Continuous Assessment: 40 Marks
End Semester Examination : 60 Marks

Course Objectives
• To understand the load distribution characteristics of flexible and rigid pavements
• To understand the development of stresses and strains within the pavement system
• To study various pavement design methods

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

Module I
Introduction: Types of pavements – Flexible and rigid pavements – Functions of component parts– Highway and airport pavements – Factors affecting design and performance of pavements. Stresses and Strains in Flexible Pavements: Stresses and deflections in homogeneous Soil Mass – Burmister’s two layer and three layer theory – Concept of ESWL for multiple wheel load assembly- Equal vertical stress and vertical deflection criteria- Equivalent Axle Load Factor (EALF)

Module II

Module III

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of 50% design problems. There will be three questions from each module out of which two questions are to be answered by the students.
CTC-1004        Traffic Engineering I

Structure of the course
Lecture: 3 hrs/week        Credits: 3
Internal Continuous assessment: 40 marks
End Semester Examination: 60 marks

Course objectives
• To understand the different phases of traffic engineering
• To study the various surveys conducted in traffic Engineering and how to analyse the various parameters
• To have an idea about the rules and regulations prevailing in traffic Engineering

Learning Outcomes
• Understand the various elements in traffic engineering
• Analyse the significance of various parameters in traffic scenario.
• Awareness to various traffic control devices and how to implement traffic safety

Module I
Components and characteristics of Traffic stream- Objectives and scope of traffic engineering-
Components of road traffic-the vehicle, driver and road user, static and dynamic characteristics of vehicles, traffic stream parameters -Fundamental diagrams of traffic flow. Concept of PCU and methods of determination of PCU values, Studies on PCU determination under heterogeneous traffic.

Module II
Traffic Surveys-Data collection and Analysis- Measurement of traffic parameters like volume, speed, concentration, parking, travel time and delay, headway studies, pedestrian studies, accident studies. Congestion studies: Performance measures, intensity, duration, extent of congestion, traveller perception, remedial measures. Application of probability and statistics in traffic Engineering-fitting of distributions, sampling in traffic studies, statistical analysis of traffic stream parameters

Module III
Traffic Controls and Regulations- Traffic Signs and Road Markings-traffic signals-street lighting, design and analysis-other traffic control aids and street furniture-Advanced technologies of traffic control. 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.

References
7. IRC Publications

Structure of the Question paper
For the end semester Examination, the question paper will consists of three questions from each module out of which two questions are to be answered by the students.
Pavement Materials and Construction

Structure of the Course
Lecture: 3 hrs/Week                     Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
• To understand the characteristics, tests of flexible and rigid pavements materials.
• To study recent developments in construction practices and modern equipments used.
• To get awareness/importance for recycling process

Learning Outcomes
• Understand the need for tests and procedures adopted for construction.
• To equip the students with practical sense of road construction using suitable materials.

Module I

Module II

Module III

References:

Structure of the Question paper
For the end semester Examination the question paper will consists of three questions from each module out of which two questions are to be answered by the students.
CTC 1101     Traffic Engineering and Software Lab

Structure of the Course
  Practical: 2 hrs/ Week                Credits: 1
  Internal Continuous Assessment: 100 Marks

Course Objectives
  • To introduce the practical problems on traffic engineering and road safety
  • To introduce the analysis softwares
  • To introduce the transportation planning softwares

Learning Outcomes
  • Knowledge on analysing and solving traffic engineering problems
  • Ability to work with transportation planning softwares
  • Ability to conduct road safety audits

List of Experiments
1. Data Collection on traffic stream parameters and analysis
   a) Mid block section
   b) Intersection
2. Journey Time and Delay Studies by Moving Car Observer method
3. Design of Roundabout
4. Noise Level Measurements
5. Parking Study
6. Introduction to TransCAD
7. Introduction to EMME
8. Application of Planning Softwares
9. Conduct of a Road Safety Audit
CTC 1102                                          Seminar
Structure of the Course
Duration: 2 Hrs/Week        Credits: 2

The student is expected to present a seminar in one of the current topics in the stream of specialisation. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester.

Marks: Seminar Report Evaluation: 40
     Seminar Presentation: 60
Course Objectives

• To introduce the fundamentals of traffic operations at uninterrupted facilities, traffic signal control, and traffic flow theory.
• Analyses of roundabouts, unsignalised intersections, signal coordination etc.
• Introduction to microscopic models and improve the knowledge in advanced theories of traffic flow.

Learning Outcomes

• Understand the operation and analysis of uninterrupted facilities
• Understand gap acceptance process, signal co-ordination
• Understanding the various traffic flow models, flow along bottle necks, shockwave phenomenon.

Module I

Uninterrupted flow: Capacity and Level of service LOS: Definitions, highway capacity, factors affecting LOS, HCM methods; Urban Street: Classification, operational performance measures, congestion management; Multilane highways: Characteristics, capacity and level of service; Ramp metering: Merging and diverging areas; gap acceptance, speed at ramps- Corridor analysis: Segment capacity, free flow travel time, queue delay; Problems in mixed traffic flow -case studies

Module II


Module III


References:

**Structure of the Question paper**

For the end semester Examination the question paper will consists of three questions from each module out of which two questions are to be answered by the students.
Structure of the Course
Lecture: 3 hrs/ Week                  Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
• To understand various types of distresses, causes and remedies
• To understand the importance of functional and structural evaluation of pavements
• To study the fundamentals and various levels of pavement management system

Learning Outcomes
• Understand the importance of pavement condition evaluation and prediction in the proper maintenance of pavements
• Understand the development of a Pavement Maintenance and Management System (PMMS)

Module I

Module II

Module III

References
5. Indian Roads Congress: 82 (1982), Code of Practice for Maintenance of Bituminous Surfaces of Highways

Structure of the Question paper
For the end semester examination the question paper will consists of three questions from each module out of which two questions are to be answered by the students.
Course of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
• To study about various data analysis techniques viz; multivariate data analysis and network flow theory
• To study about the concept of econometric models
• To know about the application of these techniques in transportation problems

Learning Outcomes
• Understand multivariate data analysis technique
• Understand the concept of network flow theory and econometric models
• Able to apply these techniques in transportation problems

Module I
Multivariate data analysis techniques- Types of data, basic vectors and matrices, Sample Estimation of Centroid, Standard deviation, Dispersion, Variance and Covariance, Correlation matrices, Principle component, Factor Analysis, Cluster Analysis, Cross Classification procedure in Multivariate data analysis, Application to problems in traffic and transportation planning

Module II

Module III

References:
2. Juan de Dlos Ortuzar and Luls G. Willumsen. Modelling transport, John Wiley and Sons

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
CTE 2002 Analysis and Design of Intersections

Structure of the Course
Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination : 60 Marks

Course Objectives
- To highlight the basic principles of intersection design, operation and control
- To cover the capacity and performance analysis of various types of intersections
- To provide detailed knowledge about design of intersection controls.

Learning outcomes
- Design road junctions according to requirements/specifications
- Carry out capacity and performance analysis of various types of intersections
- Design of various types of intersection controls

Module I
Intersection- need and classification- Types of intersections, general considerations for the location of various intersection types, principles of intersection design, factors affecting operation of intersection, types of intersections and their suitability, types of manoeuvres, relative speed, conflict points and areas, design surveys for intersection, design of speed change lanes and median lanes.

Module II
Analysis of unsignalized intersections, roundabouts- Capacity and LOS Concepts of various types of at grade intersections, capacity and performance evaluation of unsignalized intersections – TWSC and AWSC, Rotary Intersections- design and capacity analysis, Mini roundabout- design and analysis

Module III
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; 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, oversaturated conditions- Capacity and LOS analysis of a signalized I/S: HCM method of analysis of a signalized intersection and determination of the level of service;
General traffic control by islands, pedestrian control, signs, markings, intersection lighting etc

References
4. L.R Kadiyali, Traffic Engineering and Transport Planning, Khanna publishers, NewDelhi
5. Relevant IRC codes

Structure of the question paper
For the end semester Examination the question paper will consists of three questions from each module out of which two questions are to be answered by the students
CTE2003  
Intelligent Transportation Systems

Structure of the Course
Lecture: 3 hrs/ Week                Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination : 60 Marks

Course Objectives
- To provide a broad exposure to ITS
- To understand the relevance, technological applications and strategies using ITS
- To understand the recent development and application process of ITS

Learning Outcomes
- Understand the need for ITS and the subsets of ITS.
- To equip the students with practical case studies leading to ITS rather than conventional methods.

Module I
History of ITS, ITS – Need, Standards and policy, System architecture, ITS Developments - Worldwide and Indian scenario, Metropolitan and Rural ITS, ITS policy issues. ITS user services: Traffic Management centers- Types and functions, Travel and traffic management, Public transportation operations, Commercial vehicle operations, Advanced Traveller Information systems :- Pre trip and En route 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.

Module II

Module III

References:

Structure of the question paper
For the end semester Examination the question paper will consists of three questions from each module out of which two questions are to be answered by the students.
Structure of the Course
Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination : 60 Marks

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

Learning Outcomes
• Understand the basic principles of simulation;
• Understand the structure of different approaches and types of traffic simulation models
• and the underlying assumptions that govern their behaviour;
• Identify applications for which simulation is the appropriate model for use.

Module 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, 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).

Module II
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- 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)

Module III
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. 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.

References:
2. Deo, Narasingh, System Simulation by Digital Computer, Prentice Hall India.
Structure of the Question
For the end semester Examination the question paper will consists of three questions from each module out of which two questions are to be answered by the students
CTE 2005 Highway Design and Safety

Structure of the Course
- Lecture: 3 hrs/Week
- Credits: 3
- Internal Continuous Assessment: 40 Marks
- End Semester Examination: 60 Marks

Course Objectives
- Understanding the road safety issues
- Analysing factors causing crashes and countermeasures
- Understanding the principles of road safety audit

Learning Outcomes
- Design different highway facilities and apply relevant highway design standards
- Analyze crash and traffic data employing the appropriate statistical techniques
- Conduct traffic safety studies, identify high-accident locations, and propose crash countermeasure and potential engineering solutions.
- Conduct crash investigation and expect witness analysis

Module I
- Highway functions; highway safety: road, vehicle and human factors in crashes, 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.

Module II
- 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;
- Road crashes: causes, assessment of high collision sites, collision diagram, crash factor matrix, preliminary report, crash summary report accident forensic investigation, accident reconstruction; expert witness analysis; field studies; safety enhancement projects; crash countermeasures, crash location treatment report.

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

Reference

Structure of the Question paper
For the end Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
Structure of the Course

Lecture: 3 hrs/ Week  Credit: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination: 60 Marks

Course Objectives

• To introduce the methods of Operations Research
• Emphasize the mathematical procedures of linear and non linear programming

Learning Outcomes

• Proficiency in tools in optimization
• To enable the students to build models for simple problems in managerial decision making and utilise proper mathematical methods to solve these models

Module I


Module II

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. 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.

Module III

Non linear programming-multi-variable optimisation with equality constraints- Langarange multiplier method-optimisation in the presence of inequality constraints-convexity and role in optimisation, Kuhn Tucker conditions-Quadratic programming-Wolf’s method- Bearle’s method.

Reference


Structure of the Question paper

For the end semester Examination the question paper will consists of three questions from each module out of which two questions are to be answered by the students.

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
• Understanding the concept of soft computing
• Learning to apply soft computing tools to solve engineering problems

Learning Outcomes
• Understand underlying principles of soft computing
• Applying soft computing tools in research projects

Module I
Introduction to Soft-computing tools: Fuzzy Logic, Genetic Algorithm, Neural Networks and Probabilistic Reasoning; Fuzzy set theory, fuzzy logic, fuzzy decision making, approximate reasoning, fuzzy relations, and fuzzy rule based systems; Applications of Fuzzy Logic concepts in Engineering Problems, Fuzzy Multi-criterion Decision Making.

Module II

Module III

Reference :
2. Haykins, S, Neural Networks-A comprehensive Foundation, Macmillan.
   Passino KM, Yurkovich S, Fuzzy Control, Addison-Wesley-Longman.

Structure of the Question paper
For the end Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
CTD 2002  Regional Transportation Planning

Structure of the Course

Lecture: 3 hrs/ Week                    Credits: 3
Internal Continuous Assessment:  40 Marks
End Semester Examination         :  60 Marks

Course Objectives

• To have a knowledge on theories of Regional Development
• To understand the application of graph theory on transportation network analysis.
• To understand Demographic and Employment Forecasting Models

Learning Outcomes

• Knowledge on regional level transportation planning
• Understand the concept of Graph theory and its application on transportation planning
• Knowledge on urban development and forecasting models.

Module I


Module II

Transportation Networks and Applications of Graph Theoretical Concepts: Directed Graph, Partial Graph, Sub-Graph, Complete Graph, Bi-Partite Graph, Chain, Cycle, Paths and Meshes, Cutsets, Trees and Arborescence, Spatial Measures of Output and spatial Attributes of Transportation System such as Accessibility, Comprehensiveness, Circuity and Connectivity of Transportation Network. Network Structure and Graph Theoretical indices such as Alpha, Beta and Gamma, Application of these concepts in Regional Transportation Planning.

Module III

Urban Forms and Urban Structure: Urban structure and its characteristics such as Centripetal, Grid Iron, Linear and Directional Grid type ,Study of Urban forms such as Garden City, Precincts, Neighbourhoods, Linear City ,MARS plan, Le Corbusier Concept, Radburn Concept, Environmental area Concept. 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-Multiregional Extensions.

References:

2. Oppenheim N, Applied models in Urban and Regional Analysis, Prentice –Hall
3. Dickey J W; et.al; Metropolitan Transportation planning; Tata Mc Graw-Hill Wilson A G
4. Urban and regional models in Geography and Planning; John Wiley and Sons
5. Mishra RP.et.al; Regional Development Planning in India, Vikas Publishing House, New Delhi
7. IRC Journals 42-4,44-1, 44-3 for Rural Road Network Planning
Structure of the Question paper
For the end semester Examination the question paper will consists of three questions from each module out of which two questions are to be answered by the students.
Structure of the Course
Lecture : 2 hrs/ Week Credits : 2
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objective:
To formulate a viable research question
To distinguish probabilistic from deterministic explanations
To analyze the benefits and drawbacks of different methodologies
To understand how to prepare and execute a feasible research project

Outcome
Students are exposed to the research concepts in terms of identifying the research problem, collecting relevant data pertaining to the problem, to carry out the research and writing research papers/thesis/dissertation.

Module 1
Introduction to Research Methodology - Objectives and types of research: Motivation towards research - Research methods vs.Methodology. Type of research: Descriptive vs.Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, and Conceptual vs. Empirical.
Research Formulation - Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem. Literature review: Primary and secondary sources - reviews, treatise, monographs, patents. Web as a source: searching the web. Critical literature review - Identifying gap areas from literature review - Development of working hypothesis.

Module 2

Module 3
Reporting and thesis writing - Structure and components of scientific reports - Types of report - Technical reports and thesis - Significance - Different steps in the preparation, Layout, structure and Language of typical reports, Illustrations and tables, Bibliography, referencing and footnotes. Presentation; Oral presentation - Planning - Preparation - Practice - Making presentation - Use of audio-visual aids - Importance of effective communication.
Application of results of research outcome: Environmental impacts - Professional ethics - Ethical issues - ethical committees. Commercialization of the work - Copy right - royalty - Intellectual property rights and patent law - Trade Related aspects of Intellectual Property Rights - Reproduction of published material - Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

References:
1. C.R Kothari, Research Methodology, Sultan Chand & Sons, New Delhi, 1990
Structure of the Course
Practical: 2 hrs/ Week                Credits: 1
Internal Continuous Assessment: 100 Marks

Course Objectives
• To introduce the design of bituminous mix
• To introduce the tests on bituminous mix
• To introduce the pavement evaluation methods

Learning Outcomes
• Knowledge on designing bituminous mix and to determine the strength of bituminous mix
• Enable to understand the importance of proper evaluation of pavement condition and to arrive at the proper maintenance action.

List of Experiments
1. Tests on bitumen and aggregates
2. Study on bituminous mix
   a. Marshall test
   b. Indirect tensile strength test
   c. Rut wheel test
   d. Superpave design concepts
   e. Design of cold bituminous mix
3. Pavement Evaluation
   a. Roughness Evaluation
      i. By MERLIN
      ii. By Bump Integrator
   b. Pavement Texture Evaluation
   c. Determination of Pavement Modulus
   d. Dynamic Cone Penetration test
   e. Introduction to Pavement Management System
Structure of the Course

Lecture : 2 hrs/week       Credits : 2
Internal Continuous Assessment : 100 Marks

The student is expected to start the preliminary background studies towards the Thesis by conducting a literature survey in the relevant field. He/she should broadly identify the area of the Thesis work, familiarize with the design and simulation tools required for the Thesis work and plan the experimental platform, if any, required for Thesis work. The student will submit a detailed report of these activities at the end of the semester.

Internal assessment of work by the guide: 50%
Internal Evaluation by Committee: 50%
CTC 2103  Seminar
Structure of the Course
  Duration: 2hrs/week  Credits: 2

The student is expected to present a seminar in one of the current topics in the stream of specialisation. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester.

Marks: Seminar Report Evaluation: 40
       Seminar Presentation: 60
Structure of the Course

Lecture: 3hrs/Week  
Credits: 3  
Internal Continuous Assessment: 40 Marks  
End Semester Examination: 60 Marks

Course Objectives

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

Learning Outcomes

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

Module I

Project Management Concepts - Organization function and objectives, system theory –  

Module II


Module III


References:


Structure of the question paper

For the end semester Examination the question paper will consists of three questions from each module out of which two questions are to be answered by the students.
CTE3002 Advanced Travel Demand Modelling

Structure of the Course
Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination : 60 Marks

Course Objectives
• To introduce the forecasting techniques
• To introduce the theories on individual choice behaviour
• To introduce the process of conducting a choice survey
• To understand about model aggregation and transferability of a developed model

Learning Outcomes
• Knowledge on forecasting techniques and travel choice behaviour
• Ability to design a survey questionnaire based on the objective of survey
• Knowledge on model aggregation, updating and transferability

Module I
Forecasting Techniques-Forecasting using Time Series Analysis: Basic Components of Time Series – Smoothing and Decomposition Methods – Correlation and Line Spectral Diagrams, Box-Jenkins Forecasting Methodology; Examining correlations – Examining stationarity – Backshift notation –Autoregressive models- Delphi Technique

Module II
Modelling of Travel Choices: Theories of individual choice behaviour- decision makers and their opinions- Market Segmentation; Design of Surveys : Stated preference vs. Revealed Preferences; Fundamentals of stated preference- stages in data collection, identification of preferences, ranking, rating and choice. Modelling with SP choice data; Survey Methods; Role of Soft variables in Travel Demand Forecasting, Basic Rating Scales. Time Use Analysis: Activity patterns; Activity scheduling; Activity Time Allocation studies; Travel Duration Analysis

Module III
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. Simplified Transport Demand Models: Sketch planning Methods; Incremental Demand Models; Model estimation from traffic Counts, Marginal and Corridor Models

References
3. Time use Analysis, Special Issue, Transportation, 26, Kluwer Academic Publishers

**Structure of the Question paper**
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions from each module are to be answered by the students
CTE 3003   Sustainable Transportation

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
• Understanding the importance and principles of sustainability
• Understanding sustainable planning
• Understanding sustainable designs

Learning Outcomes
• Propose plans for sustainable development in transportation sector.
• Application of principle of sustainability in projects
• Understanding green technology

Module I
Introduction: Sustainable transportation, definition, necessity, fundamental principles, quantifying sustainability. Sustainable transportation planning: Paradigm shift in planning, land use and travel behavior; Sustainable Transportation Networks; built environment and public health; transportation demand management; automobile dependence and oil consumption; bicycle and pedestrian planning.

Module II
Design for Sustainable Transportation: design of bicycle and pedestrian facilities; retrofitting existing urban areas; safety issues for pedestrians and bicyclists; the transportation needs of special populations (elderly, children, disabled and immigrants); professional praxis; innovative transportation solutions and case studies.

Module III
Emerging concepts in sustainable transportation: Green Vehicles and green roads, green and alternate fuels; Managing congestion: Car-sharing, pricing control: congestion and emission pricing; Promoting public transport: Miscellaneous Transportation systems, Integrated public transport systems.

References:

Structure of the Question paper
For the end Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
CTE3004 Public Transportation System

Structure of the Course

Lecture: 3 hrs/Week  Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination : 60 Marks

Course Objectives

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

Learning Outcomes

• Awareness of the essentiality to promote Public Transit Units
• To undertake planning activities connected with Transit operations.
• To plan and prepare transit routes and schedules and the transit fares.

Module I


Module II

Transit Line Capacity: Elements and Computation, Systems approach to transit line capacity, Capacities of different modes, Level Service measures, Speed of Transit Service, Passenger demand: factors and elasticity, Multinomial logit model. Stops and stopping regimes: Definitions and relationships, Practical and optimal values of stop spacing, Comparison of all-stop, skip-stop, zonal and express/local operations,

Module III

Transit Lines and Networks: Planning objectives, principles and considerations, Geometry of transit lines, Types of transit lines and their characteristics, Transfers in transit networks, Analysis of metro network geometric forms, Transit System Statistics, Route choice and assignment, Introduction to Network design and service design, Performance and Economic Measures: Revenues, costs and operating ratio, Transit Fares : Fare structure and Collection, Costing and cost allocation methods, Modern Approaches in Transit planning : Information System for Passengers, Application of ITS.

Reference

5. Transit Capacity and Quality of Service Manual (2003), Transportation Research Board, Washington, D.C

Structure of the Question paper

For the end semester Examination the question paper will consists of three questions from each module out of which two questions are to be answered by the students.
CTE3005 Applications of Geo-Synthetics in Pavements

Structure of the Course
Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
• Introduction of various type of geotextiles and functions
• Various properties and testing of geotextiles
• Identify potential areas of application in pavements, how it is applicable and its design.

Learning Outcomes
• Understand various types of geosynthetics
• Understand potential areas of application of geotextiles, its testing standards.
• Acquire capability for selection, design of geosynthetics for various applications.

Module I
Geotextiles- overview, introduction, types including natural geotextiles, manufacturing methods, Functions of Geotextiles- fluid transmission, filtration, separation, protection, Sediment Control, Reinforcement.

Module II
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) 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.

Module III
Applications- Pavement Applications- Paved Surface Rehabilitation, Reflective Crack Treatment for Pavements, Geotextiles for separation and reinforcement in flexible pavements, design by Giroud-Noiray approach, reflection cracking and control 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
Different filtration requirements, filtration in different types of soils and criteria for selection of geotextiles, estimation of flow of water in retaining walls, pavements, Reinforcement design applications in rigid and flexible pavements, embankments, drainage and filtration application. AASHTO design criteria; construction methods

References:
Structure of the Question paper.
For the end semester Examination the question paper will consists of three questions from each module out of which two questions are to be answered by the students.
CTE 3006 Advanced Optimisation Techniques for Transportation Engineering

Structure of the Course

<table>
<thead>
<tr>
<th>Lecture</th>
<th>3 hrs/Week</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Internal Continuous Assessment</td>
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<td>End Semester Examination</td>
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Course Objectives

- 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.
- Proficiency with tools in optimisation including fundamental applications of these tools in contexts involving uncertainty and scarce or expensive resources.

Learning Outcomes

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

Module I

- Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach applications in traffic and pavement management-smoothening, capital budgeting, Stage Coach/Shortest Path, and Reliability problems- formulation

Module II

- 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.
- Replacement Models: Deteriorating items with increasing maintenance cost and constant money value-Items that fail suddenly- Replacement policy: individual and group.

Module III


Reference


Structure of the Question paper

For the end semester Examination the question paper will consists of three questions from each module out of which two questions are to be answered by the students.
Structure of the Course
Lecture: 14 hrs/week Credits: 5

Thesis-Preliminary Part II comprises of a preliminary thesis work, two seminars and submission of thesis-preliminary report. The first seminar would highlight the topic, objectives, and methodology and the second seminar will be a presentation of the work they have completed till the third semester and scope of the work which is to be accomplished in the fourth semester, mentioning the expected results.

Internal assessment of work by the guide: 50%
Internal Evaluation by Committee: 50%
Structure of the Course
Lecture: 21hrs/week  Credits : 12
The fourth semester is entirely devoted for the thesis work. There would be an interim presentation at the first half of the semester to evaluate the progress of the work and at the end of the semester there would be a Pre-Submission seminar before the Evaluation Committee for assessing the quality and quantum of the work. This would be the qualifying exercise for the students for getting approval from the Department Committee for the submission of Thesis. At least one technical paper is to be prepared for possible publication in Journals/Conferences. The final evaluation of the Thesis would be conducted by the board of examiners constituted by the University including the Guide and an external examiner.

Distribution of marks
Internal evaluation of the Thesis work by the guide: 150 marks
Internal evaluation of the Thesis by the Evaluation Committee: 150 marks
Final evaluation of the Thesis Work by the Internal and External Examiners:
[Evaluation of Thesis: 200 marks *+ Viva Voce: 100 marks (*5% of the marks is earmarked for publication in Journal/Conference) ] TOTAL – 300 marks