# SCHEME AND SYLLABUS
# OF

## M.Tech Programme in
## Civil Engineering
## ( 2013 Scheme )

## **with specialisation in**
## **TRAFFIC AND TRANSPORTATION ENGINEERING**

**University of Kerala**

**Thiruvananthapuram**

## M.Tech PROGRAMME - CIVIL ENGINEERING – TRAFFIC AND TRANSPORTATION ENGINEERING
## CURRICULUM AND SCHEME OF EXAMINATIONS
## SEMESTER I

| Code No. | Name of Subject | Credits | Hrs / week | End Sem Exam hours | Marks | | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | Internal Continuous Assessment | End Semester Exam | Total | |
| CMA 1002 | Applied Probability and Statistics | 3 | 3 | 3 | 40 | 60 | 100 | Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End sem exam is conducted by the University |
| CTC 1001 | Transportation Economics and Appraisal | 3 | 3 | 3 | 40 | 60 | 100 | do |
| CTC 1002 | Urban Transportation Planning | 3 | 3 | 3 | 40 | 60 | 100 | do |
| CTC 1003 | Analysis and Design of Pavement System | 3 | 3 | 3 | 40 | 60 | 100 | do |
| CTC 1004 | Traffic Engineering –I | 3 | 3 | 3 | 40 | 60 | 100 | Do |
| CTC 1005 | Pavement Materials and construction | 3 | 3 | 3 | 40 | 60 | 100 | Do |
| CTC 1101 | Traffic Engineering and Software Lab | 1 | 2 | - | 100 | - | 100 | No End Sem Examination |
| CTC 1102 | Seminar | 2 | 2 | - | 100 | - | 100 | Do |
| | TOTAL | 21 | 22 | | | | | 7 Hours of Departmental Assistance work |

**SEMESTER II**

| Code No. | Name of Subject | Credits | Hrs / week | End Semester Exam hours | Marks | | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | Internal Continuous Assessment | End Semester Exam | Total | |
| CTC 2001 | Traffic Engineering II | 3 | 3 | 3 | 40 | 60 | 100 | Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End sem exam is conducted by the University |
| CTC 2002 | Pavement Evaluation and Management | 3 | 3 | 3 | 40 | 60 | 100 | Do |
| * | Stream Elective I | 3 | 3 | 3 | 40 | 60 | 100 | Do |
| * | Stream Elective II | 3 | 3 | 3 | 40 | 60 | 100 | Do |
| * | Department Elective | 3 | 3 | 3 | 40 | 60 | 100 | Do |
| CCC 2000 | Research Methodology | 2 | 2 | 3 | 40 | 60 | 100 | Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End Sem Exam is conducted by the Individual Institutions |
| CTC 2101 | Pavement Materials and Evaluation Lab | 1 | 2 | - | 100 | | 100 | No End Sem Examination |
| CTC 2102 | Thesis – Preliminary – Part I | 2 | 2 | - | 100 | | 100 | Do |
| CTC 2103 | *Seminar | 2 | 2 | - | 100 | | 100 | Do |
| | TOTAL | 22 | 23 | --- | | | | 6 hours of Departmental assistance work |

*Students can select a subject from the subject listed under stream/department electives as advised by the course coordinator.

**Stream Electives I**

CTE 2001 Analytical Techniques in Transportation Planning
CTE 2002 Analysis and design of Intersection
CTE 2003 Intelligent Transportation System

**Stream Electives II**

CTE 2004 Traffic Simulation Modelling and Applications
CTE 2005 Highway design and Safety
CTE 2006 Operations Research

**SEMESTER III**

| Code No. | Name of Subject | Credits | Hrs / week | End Sem Exam hours | Marks | | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | Continuous Assessment | End Semester Exam | Total | |
| | Stream Elective III | 3 | 3 | 3 | 40 | 60 | 100 | End Sem Exam is conducted by the Individual Institutions |
| | Stream Elective IV | 3 | 3 | 3 | 40 | 60 | 100 | do |
| | Non- Dept. (Interdisciplinary) Elective | 3 | 3 | 3 | 40 | 60 | 100 | do |
| CTC 3101 | Thesis – Preliminary – Part | 5 | 14 | - | 200 | | 200 | No End Semester Examinations |
| | TOTAL | 14 | 23 | | | | | |

**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

**SEMESTER IV**

| Code No | Subject Name | Credits | Hrs/week | Marks | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Continuous Assessment | | University Exam | | Total | |
| | | | | Guide | Evaluation Committee | Thesis Evaluation | Viva Voce | | |
| CTC 4101 | Thesis | 12 | 21 | 150 | 150 | 200* | 100 | 600 | * 5 % of the evaluation mark is earmarked for Publication in journal/conference |
| | Total | 12 | 21 | 150 | 150 | 200 | 100 | 600 | 8 hrs of departmental assistance work |

**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
6. CTD 2001 Soft Computing Tools for Engineering
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 3001philosophy 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

Time Series Models: Components of time series – smoothing – measuring forecasting accuracy – testing of ARIMA models.

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

**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. Dallan 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


**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.while
- 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.
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**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

Econometrics & Project Appraisal- Econometrics of industrial location, Project Appraisal- Technical Appraisal, Social Appraisal- Social Cost Benefit analysis, Economic and financial appraisal - Financing transport infrastructure - Appraisal through financial statement, Taxation, and Toll collection. Preparation of projects, Feasibility reports.

Economic evaluation of mass transit projects.

**References:**

1. Stuart Cole 'Applied Transport Economics'
2. K M G 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 B Lansing ' Transportation and Economic Policy'
7. Dominick Sabratore - Schaum's Outline series ' Theory and problems of micro economic theory'
8. Winfrey- Transport Economics
9. Dr. P.K. Sarkar, 'Transport Economics'. Standard Publishers and Distributors
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

Travel demand estimation; Trip generation analysis-Aggregate analysis, dis-aggregate analysis, Regression analysis. Types of regression models-linear, non-linear, multiple regression models. 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.

Module III

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. Landuse-transport models. Lowry model. Lowry Garin model. Iterative solutions. Introduction to transport planning softwares.

**Reference**

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

**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 – Bur mister'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

Flexible Pavement Design: Resilient Modulus, Dynamic Modulus and Fatigue Characteristics of bituminous mix. Principles of Mechanistic- Empirical Pavement Design (MEPD) – Methods of Design: IRC Method-Asphalt Institute Method, AASHTO Method.

Module III

Stresses in Rigid Pavements: Types of stresses – Temperature stresses – Stresses and Deflection due to wheel load- Combination of stresses. Rigid Pavement Design: Methods of Design,IRC method,AASHTO method,PCA method. Types of joints in cement concrete pavements – functions – Joint spacing – Design of dowel bars and tie bars (IRC method).

**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. IRC 37 – 2001, Guidelines for Design of Flexible Pavement, Indian Roads Congress.
4. IRC 58 – 2002, Guidelines for Design of Rigid Pavements, Indian Roads Congress.


**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:3hrs/week Credits:3
Internal Continuous assessment: 40 marks
End Semester Examination: 60marks

**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 1

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**

1. Roess R P, Mc Shane W R & Prassas E S, Traffic Engineering, Prentice Hall ,3rd edition 2004
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 edition 2008
5. Matson,Smith and Hurd,'Traffic Engineering',Mc GrawHill Book Co.
6. Wells, G R,'Traffic Engineering-An Introduction',Griffin,London
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.

CTC 1005 **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

Characterization of sub grade soil/granular materials, Soil classification systems regarding suitability as sub grade soil, Resilient Modulus of soil/granular materials, Soil stabilization methods - Chemical and Mechanical and their construction procedures. Road aggregates, Principles and methods of Gradation for soil –Aggregate mixes. Artificial aggregates. Bituminous binders – Methods of grading, Emulsions –Properties and tests, Cut backs and Modified binders-Types, characteristics and uses. Viscoelasticity and stiffness of bitumen, aging of bitumen and aging tests.

Module II

Bituminous pavement types:-Penetration layer systems and Pre mixed aggregate and bituminous mixtures, Physical and volumetric properties of bituminous mixes. Mix Design- Marshall Method and Super pave procedure, Tests on materials for super pave mix design. 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.

Module III

Material characterization for Cement concrete pavements, Construction of Cement concrete pavements – Preparation of Sub grade 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. Non destructive tests- Nuclear Gage, Geogauge, Ground penetrating radar. Specialty Applications- Stone Matrix Asphalt, Warm mix asphalt, Porous pavements, Thin white topping and ultra thin white topping.

**References:**


1. P. H. Wright and Karen Dixon, Highway Engineering, John Wiley & Sons, 1996.
2. Rajib B.Mallick and Tahar El- 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 Services Ltd 1995.


**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

**CTC-2001 Traffic Engineering II**

**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 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

Intersections- Analysis: Weaving sections: types, analysis. Roundabouts:introduction, types and design- Uncontrolled intersection: Gap acceptance studies, concept of critical gap. Signalised intersection- Principles, fundamentals of signal timing and design. Coordinated traffic signal: Concepts of offset, common cycle length bandwidth, offset for one-way and two way streets - Vehicle actuated signals and Area traffic control: Basic principles

Module III

Traffic Flow Modelling: *Traffic stream models:* Traffic flow characteristics, Greenshield's model, 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, Lighthill-Withams theory, Boltzman like behaviour of traffic. Flow concepts including shock waves and bottleneck. *Lane changing models:* Conceptual framework, lane selection model, gap acceptance models;

Flow models under mixed traffic. Simulation in Traffic Engineering- Types of simulation, random number generation, *Microscopic traffic simulation*: Vehicle generation, design, calibration, validation, algorithms for different distributions used in traffic engineering.

**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, New Delhi.
4. Highway Capaity Manual, Transportation Research Board, Washington, D.C., 2010.
5. May, Adolf D., Traffic Flow Fundamentals, Prentice Hall, Englewood Cliffs, N.J., 1990.

6. Gazis, Denos C., Traffic Theory, Kluwer Academic Publishers, Norwell, MA, 2002.
7. C. S. Papacostas, P. D. Prevedouros, Transportation Engineering and Planning, PHI Publication, 3rd edition , 2002.
8. Khisty C.J. Transportation Engineering- An introduction, Prentice Hall, New Jersey, 1990.
9. Ceder A, Transportation and traffic theory. Pergamon Elsevier Science Ltd., Oxford. 1999.
10. Daganzo C.F. Fundamentals of transportation and traffic operations, Pergamon, Elsevier Science Ltd. U.K.,1997.
11. Traffic Flow Theory: A State-of-the-Art Report, TRB, Available for free download at http://www.tfhrc.gov/its/tft/tft.htm.
12. Traffic Theory, Denos C. Gazis, Springer, 2002.

**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.

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**CTC 2002 Pavement Evaluation and Management**

**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

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 – Pavement Condition Survey -Pavement Condition Index(PCI) – Estimation of PCI by Shahin's Deduct Value Method- Characterisation of Roughness- Equipments for Measuring Roughness- International Roughness Index (IRI)

Module II

Factors affecting pavement structural condition – Structural Evaluation by Non- Destructive Tests– Types – Benkelman Beam Rebound Deflection – 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

Module III

Pavement Management System – Concept – Objectives – Components of PMS – PMS functions -General Structure – Pavement Maintenance- Preventive and Corrective Maintenance- Maintenance Policy- 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 based on Economic Evaluation and Optimisation - Tools for Pavement Management: HDM-4, Road Economics Decision Model

**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. Yang H Huang, Pavement Analysis and Design, Prentice Hall, 2004.
4. Indian Roads Congress: 81 (1997), Tentative Guidelines for Strengthening of Flexible Road Pavements using Benkelman Beam Deflection Technique
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.

**CTE 2001 Analytical Techniques in 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 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

Network Flow Theory- 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- Network transformations- berth and search algorithms- formulation of shortest path problem- maximum flow problem- minimum cost flow problem- algorithm- applications in transportation network problem.

Module III

Econometric Models- Latent Variable Models – Structural Equation modelling – Duration models – Hazard based duration models – Non parametric, semi parametric and fully parametric models – Discrete outcome models – Multinomial Logit Models – Nested Logic Models – Overview of discrete continuous models.

**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.


**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

ModuleIII

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**


1. Transportation Research Board,Highway Capacity Manual 2000,2010
2. Roess, Prassas and McShane, Traffic Engineering", Pearson Prentice Hall, Fourth Edition,Upper Saddle River,New Jersey 2011
3. Garbel and Hoel,Traffic and Highway Engineering, Third Edition, Books/Cole Publishers
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

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. ITS Design : ITS system design-components and requirements and Evaluation, ITS for road network- System Design-Sensor technologies and data requirements for ITS. Positioning systems in ITS, Mobile phone location and its impact on ITS. Telecommunication in ITS, Application of GIS in ITS.

Module III

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.

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.

**References:**


1. Joseph M. Sussman, Perspectives on Intelligent Transportation Systems, Springer2005.
2. Bob Williams, Intelligent Transportation Systems Standards, Artech House 2008.
3. Sumit Ghosh,and Tony.S.Lee, Intelligent Transportation Systems: Smart and Green Infrastructure Design, CRC press,2010.
4. Mashrur A. Chowdhury and Adel Wadid Sadek Fundamentals of Intelligent Transportation Systems planning, Artech House 2009.


**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 2004 Traffic Simulation Modelling and Application**

**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:**


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 Transportation Data Analysis, Chapman & Hall/CRC, 2003.
9. 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.
10. Wolfram, Theory and application of cellular automata, World Scientific at Singapore, 1996.
11. Wagner P, Realistic multilane traffic rules for cellular automata, Proceedings of Traffic and Granular flow, D. Wolf, M. Schreckenberg and A. Bache meds. World Scientific at Singapore, 1996.

**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**


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


**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.

**CTE 2006 Operations Research**

**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 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

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. Duality Theory, The Primal Vs- Dual-Solutions. Sensitivity Analysis: Changes in Objective-Function Sensitivity Analysis: Changes in RHS.- revised simplex method –parametric programming

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**

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

**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

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**CTD 2001 Soft Computing Tools for Engineering**

**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

Introduction to genetic algorithms – natural evolution – properties – classification – GA features – coding – selection – reproduction – cross over and mutation operators - basic GA and structure. Engineering optimisation problem solving using genetic algorithm.

Module III

Introduction to artificial neural networks - biological neurons – types of activation function – network architectures – knowledge representation – learning process – error-correction learning – supervised learning – unsupervised learning – single unit mappings and the perceptron – perceptron convergence theorem (with out proof) – method of steepest descent – least mean square algorithms – adaline/medaline units – multilayer perceptrons – derivation of the back- propagation algorithm; Neural network approaches in engineering analysis, design and diagnostics problems; applications of probabilistic reasoning approaches. Hybrid systems: Neuro-fuzzy and neuro-genetic systems, neuro-fuzzy control.

**Reference :**


1. Jang J S R, Sun C T, and Mizutani E, Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence," Prentice Hall
2. Haykins, S, Neural Networks-A comprehensive Foundation, Macmillan.
3. T.J. Ross TJ, Fuzzy Logic with Engineering Applications, McGraw-Hill Book Company. Passino KM, Yurkovich S, Fuzzy Control, Addison-Wesley-Longman.
4. Lin, Neural Fuzzy Systems: A Neuro-Fuzzy Synergism, Prentice Hall.
5. Klir GJ and Folger, TA Fuzzy Sets, Uncertainty, and Information, Prentice Hall.
6. Kosko B., Neural Networks and fuzzy systems, Prentice-Hall.
7. Goldberg D. E., Genetic Algorithms in Search Optimisation and Machine Learning, Addison Wesley.


**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

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. Estimating and Forecasting of Passenger and Goods Demand: Mode Specific and Mode Abstract models, Programming model, Shift and Share model, Excess Production, Consumption and stock Piling Models, Models based on Behavioural Characteristic of Shippers, Demand Forecasting using Link Volume Modelling Philosophy.

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:**


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; Metropolitian 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
6. Heggei I G ; Transportation Engineering Economics;Mc-Graw Hill Book Company, New York
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.

**CCC 2000 RESEARCH METHODOLOGY 2-0-0-2**

**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**

Research design and methods: Research design - Basic Principles- Need forresearch design — Features of a good design. Important concepts relating to research design: Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction. Development of Models and research plans: Exploration, Description, Diagnosis, Experimentation and sample designs.Data Collection and analysis: Execution of the research - Observation and Collection of data - Methods of data collection - Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-Testing -Generalization and Interpretation.

**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
2. Panneerselvam, “Research Methodology”, Prentice Hall of India, New Delhi, 2012.
3. J.W Bames,” Statistical Analysis for Engineers and Scientists”, McGraw Hill, New York.
4. Donald Cooper, “Business Research Methods”, Tata McGraw Hill, New Delhi.
5. Leedy P D, "Practical Research: Planning and Design", MacMillan 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.

**CTC 2101 Pavement Materials and Evaluation Lab**

**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

**CTC 2102 Thesis Preliminary Part I**

**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

**CTE 3001 Project Management**

**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 – Organizational Structures Tools and Techniques – concepts, functions. Objectives of term management - qualities and duties of each component - Project Constrains – Project Feasibility Reports. Change – external forces, effect, responses, approaches, acceptance. Team building – Recongnition, 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

Module II

Materials Management – Importance, objectives, functions, uses – stores, 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. Type of Contract - Documentation, condition, pre-tender planning. Pre-contract planning- Establishing contract budgets, forecasting, contract value – law of contracts, potential problems, arbitration – post contract problems – special feature of international contracts.

Module III

DPR Preparation with reference to World Bank Projects. Value of Engineering and Quality assurance. Man power planning, training, motivation, performance evaluation, Industrial relations – Welfare measures. Human factors in Construction. Leadership and Motivation – Artful – influence – Effective delegation - Accountability, authority and autonomy. Communication – Needs, styles, understanding, effectiveness, appreciation. MIS components and structure – Personnel management.

**References:-**


1. Heroil Keenzer – Project Management – A system approach to planning, scheduling and controlling – CBS publishers distributers 1997.
2. K. Waker A Teraih and Jose M Grevarn : Fundamentals of Construction Management & Organization.
3. Ghattas and Mckee – Practical Project Management – Pearson Education 2002.
4. Seetharaman- Construction Engineering and Management – Umesh Publications 2012.
5. Shore. B Operations Managements Mc. Graw Hill 1973.


**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**

1. Orturzar, J. de D. and L.G. Willumsen (2011) Modelling Transport, Wiley Publishers
2. Oppenheim N (1995) Urban Travel Demand Modelling: From Individual Choices to general equilibrium. John Wiley & sons, Inc
3. Time use Analysis, Special Issue, Transportation, 26, Kluwer Academic Publishers
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
6. Orturzar, J. de D (2000) Stated Preference Modelling Techniques, PTRC Education and Research Services
7. Jordan J. Louviere, David A. Hensher, Joffre D. Swait (2000) Stated Choice Methods: Analysis and Applications

8. Katherine F. Turnbull (2008) Innovations in Travel demand Modelling, TRB Conference Proceedings 42, Vol 2

**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:**


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.


**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

Basic Operating Elements of Public Transit, public transport travel characteristics, Transit travel characteristics: factors, spatial distribution, temporal variations, Passenger volume analysis and service capacity determination, Introduction to transit service planning, Operational planning process, Service and evaluation standards, Data requirements and collection, Frequency and Headway distributions, Scheduling of service and timetabling. Modelling and Optimization in Transit Systems Analysis: Application, Conceptual and Mathematical modelling, Applications of simulation methodology.

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**


1. Ceder, Avishai (2007), Public Transit Planning and Operation: Theory, Modelling and Practise, 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, C J. (2002), Transportation Engineering – An Introduction, Prentice-Hall, New Jersy.
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:**

1. Koerner, R.M. Designing with Geosynthetics, Prentice Hall, New Jersey,USA, 4th edition, 1999.
2. G.V. Rao, PK Banerjee, J.T. Shahu, G.V. Ramana. Geosynthetics - New Horizons, Asian Books Private Ltd., New Delhi, 2004.
3. G. Venkatappa Rao, Geosynthetics-An Introduction, Sai Master Geo environmental Services Pvt Ltd., Hyderabad, 2011.

4. G. Venkatappa Rao & Goutam K. Pothal, Geosynthetics Testing-A Laboratory Manual, Sai Master Geoenvironmental Services Pvt Ltd., Hyderabad, 2008.
5. Rao G.V. & Rao G.V.S., "Text Book On Engineering With Geotextiles", Tata McGrawhill
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, "Geosynthetics World", Willey Eastern Ltd., New Delhi.

**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**

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

**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

Probability and statistical analysis for management decisions- concept of uncertainty -Markov analysis –stochastic random process-transition probability-Markov chain-steady state condition. 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

Network Models –Minimal spanning tree algorithm- shortest route problems-Maximum flow model-linear programming- excel spread sheet solution of maximum flow model-minimum cost capacitated flow problems- network representation-formulation (LPP)-capacitated network simplex algorithm--LPP formulation of CPM-PERT Network. Forecasting models-introduction to time series models-characteristics moments in a time series-measurement of trends-ARMA-ARIMA-Lag operator-testing of ARIMA model- Forecasting- Examples

**Reference**

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”, Macmillan India Ltd.
4. N.V.S. Raju, “Operations Research”, HI-TECH, 2002.

**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 3101** **Thesis Preliminary – Part II**

**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%

**CTC 4101** **Thesis Final**

**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 ear marked for publication in Journal/Conference)* ] TOTAL – 300 marks