MA601 NUMERICAL METHODS AND APPLIED STATISTICS

Linear system – Gaussian elimination and Gauss – Jordan methods – matrix inversion – Gauss seidel method – Nonlinear equations – Regula falsi and Newton- Raphson methods – interpolation – Newton's and Lagrange's interpolation

Linear Programming – Graphical and Simplex methods – Measures of central tendency, dispersion, skewness and Kurtosis – Probability – conditional probability – Bayes' theorem

Random variable – two dimensional random variables – standard probability distributions – Binomial Poisson and normal distributions - moment generating function

Sampling distributions – confidence interval estimation of population parameters – testing of hypotheses – Large sample tests for mean and proportion – t-test, F-test and Chi-square test – curve fitting-method of least squares

Regression and correlation – rank correlation – multiple and partial correlation – analysis of variance-one way and two way classifications – experimental design – Latin square design – Time series analysis.

1. Bowker and Liberman, *Engineering Statistics,* Prentice-Hall, 1972.
2. Venkatraman, M.K., *Numerical Methods in Science and Engineering*, National Publisher Company.

CE601 HIGHWAY TRAFFIC ANALYSIS AND DESIGN

Elements of Traffic Engineering - road user, vehicle and road way. Vehicle characteristics - IRC standards - Design speed, volume. Highway capacity and levels of service - capacity of urban and rural roads - PCU concept and its limitations - Road user facilities - Parking facilities - Cycle tracks and cycleways - Pedestrian facilities.

Traffic volume studies, origin destination studies, speed studies, travel time and delay studies, Parking studies, Accident studies.

Elements of design - Alignment - Cross sectional elements - Stopping and passing sight distance. Horizontal curves - Vertical curves. Design problems – Hill Roads.

Traffic regulation and control - Signs and markings - Traffic System Management - Design of at-grade intersections – Principles of design – Channelisation - Design of rotaries - Traffic signals - pre-timed and traffic actuated. Design of signal setting - phase diagrams, timing diagram – Signal co-ordination.

Grade separated intersections - Geometric elements for divided and access controlled highways and expressways – Road furniture - Street lighting. Traffic Safety – Principles and Practices – Road Safety Audit.

1. ITE Hand Book, *Highway Engineering Hand Book*, Mc Graw - Hill.
2. AASHTO *A Policy on Geometric Design of Highway and Streets*
3. R. J. Salter and N. B. Hounsel, *Highway Traffic Analysis and Desig*n, Macmillan Press Ltd, 1996.

CE602 PAVEMENT ANALYSIS AND DESIGN

Types and Component parts of Pavements – Flexible, rigid and semi-rigid pavements - Factors affecting design and performance of Pavements - Comparison between Highway and Airport pavements. Influence of environment on pavement - Frost, Sub grade moisture

Functions and significance of subgrade properties - Methods of assessment of subgrade strength - Soil classification – Ground Improvement Techniques – Wheel loads – ESWL - EWLF

Analysis of Stresses in Flexible Pavements - Empirical, Semi-empirical and Theoretical Methods of Flexible Pavement Design.

Analysis of Stresses in Rigid pavements - Types, Functions and Spacing of Joints in Cement Concrete Pavements – Design Methods of Rigid Pavements.

Pavement evaluation and rehabilitation - pavement distress – Roughness and Skid Resistance. Strengthening of existing pavements - Flexible and Rigid Overlays – Recycling of Pavements – Pavement Management Systems.

1. Yoder, E.J. and Witczak, *Principles of Pavement Design,* Wiley and Sons, 1975.
2. Huang, Y., *Pavement Analysis and Design*, Prentice Hall, 2003.
3. Ralph Haas, Ronald Hudson and Zanieswki, *Modern Pavement Management*, Kreiger Publications, 1994.

CE603 TRANSPORTATION SYSTEMS

Historical development of transport in India - 20 year Road Plans, National Transport Policy Recommendations, IRC, CRRI, Vision 2021, NHDP, PMGSY. Characteristics of different modes of transport and their integration and interactions - impact on environment.

Planning of railway - Passenger and goods terminals - layout - passenger facilities - traffic control.

Airport Planning, requirements and components. Design of runway and taxiway - Apron - parking configuration - terminal requirements - Airport marking and lighting - Air traffic control.

Planning of Harbours and ports - cargo handling - Containerization - Navigation aids - Inland waterways - Pipeline transportation.

Urban transportation systems - Mass rapid transit system - Light rail transit - Personal rapid transit, guided way systems, cabin taxi, dual mode bus - Para transit systems - Demand responsive system - Intermediate public transport.

1. Paquette, R.J., et al, *Transportation Engineering Planning and Design,* John Wiley & Sons, New York, 1982.
2. Alan Black, *Urban Mass Transportation Planning*, McGraw-Hill, 1995.

CE604 TRAFFIC AND PAVEMENT ENGINEERING LABORATORY

Traffic Surveys: Volume count, Speed study, Parking study, Intersection turning movements, Speed and Delay study, Moving observer survey, Traffic noise measurement, Vehicle emission testing, Road lighting, User perception surveys, Road side and house hold interviews

Tests on sub grade soil, aggregates, bitumen, modified binders - Soil stabilization - Pavement evaluation.

Mix Design: Granular Sub-base, Bituminous – DBM, SDBC, BC, etc., Cement concrete.

Mini project report based on field and laboratory studies and data collected

CE605 ROAD TRANSPORT MANAGEMENT AND ECONOMICS

Motor Vehicles Act - statutory provision for road transport and connected organisations. Route scheduling, Freight transport, Vehicle scheduling, Optimum fleet size, Headway control strategies, Crew scheduling.

Depots and Terminals - Principles and types of layout, Depot location, Twin depot concept, Crew facilities. Design of parking facilities – Bus terminal, bus stops and bus bays

Transportation costs - Supply and demand - elasticity of demand; Supply of transport services - Economics of traffic congestion - Pricing policy. Vehicle operating costs - Fuel costs - Maintenance and spares - Depreciation - Crew costs - Value of travel time savings - Accident costs.

Economic analysis of projects - Methods of evaluation - Cost-benefit ratio, first year rate of return, net present value, and internal-rate of return methods; Indirect costs and benefits of transport projects.

Financing of road projects - methods – Private Public Partnership (PPP) - Toll collection - Economic viability of Build-Operate-Transfer Schemes – Risk Analysis - Case Studies.

1. Winfrey, *Economic analysis for Highways,* International Textbook Company, Pennsylvania, 1969.
2. CRRI, *Road User Cost Study in India*, New Delhi, 1982
3. IRC, *Manual on Economic Evaluation of Highway Projects in India*, SP30, 2007

CE606 TRANSPORTATION PLANNING

Urban Transportation Planning - Goals and objectives - Hierarchical levels of transportation planning - Forecast - Implementation - Constraints. UTP survey - Inventory of land use

Trip generation - Trip classification - productions and attractions - Multiple regression models - Category analysis - Trip production models - Trip distribution models - Linear programming approach.

Modal split models - Behavioural models - Probabilistic models - Utility functions - logit models - Two stage model. Traffic assignment - Assignment methods - Route-choice behaviour - Network analysis.

Landuse and its interaction - Lowry derivative models - Quick response techniques - Non-Transport solutions for transport problems. Characteristics of urban structure. Town planning concepts.

Preparation of alternative plans - Evaluation techniques - Plan implementation - Monitoring - Financing of Project – Case studies.

1. Hutchinson, B.G., *Principles of Urban Transport Systems Planning*, Scripta, McGraw-Hill, NewYork, 1974.
2. Khisty C.J., *Transportation Engineering - An Introduction*, Prentice Hall, India, 2002.

CE607 COMPUTER SIMULATION APPLICATIONS IN TRANSPORTATION ENGINEERING

Introduction to systems approach - Typical transportation systems - Mathematical models. Fundamentals of simulation - Monte Carlo method - Analog and digital simulation - Continuous and discrete models - Simulation languages - Introduction to CSMP.

Probability concepts - Random numbers - Pseudo random generators - Arrival patterns - Service time distributions, Queue discipline – Manual simulation of simple queuing system

Creating and moving transactions - Queues and facilities - Event scheduling - Internal logic of GPSS processor - Program control statements.

Priority - Preemption - Functions – Parameters and save values – Standard numerical attributes - Collection of statistics - Report preparation.

Applications of GPSS - Simple queuing problems - Inventory problems - Simulation of ports - Railway platforms and level crossings - Traffic signals. Analysis of simulation results - Model validation - Replication of random conditions - Time series analysis.

1. Gordon, G., *System Simulation,* Prentice-Hall of India, 1992

Department of Civil Engineering, National Institute of Technology, Tiruchirappalli – 620 015.

2. GPSS/PC, *User Manual, Minuteman Software,* USA, 1985

CE608 CAD IN TRANSPORTATION ENGINEERING

Transportation Software – Mx Road, REI heads, HDM4, TRIPS, MIGRAN
GIS and Remote Sensing Packages – ArcGIS, Geo-Concept,GRAM++, ENVI, ERDAS Imagine

Computer Aided Drafting - DBMS concepts - Civil Engineering Databases – Data entry & Reports. Spreadsheet concepts – Worksheet calculations in Civil Eng, - Regression & Matrix Inversion.

Development of C programs to solve problems using numerical techniques

a. Roots of an equation using Newton – Raphson method.
b. Solution of linear simultaneous equations using Gauss elimination.
c. Matrix inversion using Gauss Jordan method
d. Linear regression line of given points.

1. Rajaraman, V., *Computer Oriented Numerical Methods*, Prentice – Hall of India, 1995
2. Chapra S.C., and Canale R.P., *Numerical Methods for Engineers*, McGraw – Hill, 2004
3. Software Manuals

ELECTIVES (I Semester)

CE611 GEOGRAPHICAL INFORMATION SYSTEMS AND REMOTE SENSING

Definition – Map and map analysis – Automated cartography – History and development of GIS – Hardware requirement. Input devices - Type of data – Spatial and non- spatial data – Data structure – Points – Lines – Polygon – Vector and raster – Files and data formats – Data compression.

Spatial analysis – Data retrieval – Query – Simple analysis – Record – Overlay – Vector data analysis – Raster data analysis – Modelling in GIS – Digital Elevation Model – DTM – Types of output data – Output devices – Sources of errors – Types of errors – Elimination – Accuracies

Concepts and foundations of remote sensing - electromagnetic spectrum, energy - Basic principles of photogrammetry – Remote sensing platforms and sensors

Satellite system parameters, sensor parameters, earth resources and meteorological satellites, microwave sensors, Data Acquisition and interpretation - Visual Image Interpretation – Fundamentals - Visual Image Interpretation Equipment - Digital Image Processing - Classification

Applications in infrastructure development, mapping, natural resources management, land use and transportation planning, water resources engineering and environment.

1. Burrough P.A. and Rachel A. McDonell, *Principles of Geographical Information Systems*, Oxford Publication, 2004.
2. C.P. Lo and Albert K. W. Yeung, *Concepts and Techniques of Geographical Information Systems*, Prentice-Hall India, 2006.
3. Thomas. M. Lillesand and Ralph. W. Kiefer, *Remote Sensing and Image Interpretation*, John Wiley and Sons, 2003.

CE612 INTELLIGENT TRANSPORTATION SYSTEMS

Introduction to Intelligent Transportation Systems (ITS) – Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

Telecommunications in ITS – Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Vehicle – Road side communication – Vehicle Positioning System

ITS functional areas – Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS).

ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.

Automated Highway Systems - Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.

1. ITS Hand Book 2000: *Recommendations for World Road Association (PIARC)* by Kan Paul Chen, John Miles.
2. Sussman, J. M., *Perspective on ITS*, Artech House Publishers, 2005.
3. National ITS Architecture Documentation, US Department of Transportation, 2007 (CD-ROM).

CE613 PAVEMENT MATERIALS

Subgrade soil - Soil composition and structure - Soil classification for engineering purposes - Origin, Classification, requirements, properties and tests on road aggregates

Origin, preparation, properties and tests, constitution of bituminous road binders, requirements - Bituminous Emulsions and Cutbacks: Preparation, characteristics, uses and tests

Bituminous Mixes: Mechanical properties - Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes.

Weathering and Durability of Bituminous Materials and Mixes - Performance based Bitumen Specifications - Superpave mix design method

Cement Concrete for Pavement Construction: Requirements, design of mix for CC pavement, joint filler and sealer materials.

1. RRL, DSIR, *Bituminous Materials in Road Construction*, HMSO Publication, 1955
2. IS and IRC Publications on relevant topic.

ELECTIVES (II Semester)

CE614 BRIDGE ENGINEERING

Components of Bridges – Classification – Importance of Bridges – Investigation for Bridges – Selection of Bridge site – Economical span – Location of piers and abutments – Subsoil exploration – Scour depth – Traffic projection – Choice of bridge type

Specification of road bridges – width of carriageway – loads to be considered – dead load – IRC standard live load – Impact effect

General design considerations – Design of culvert – Foot bridge - slab bridge – T-beam bridge – Pre-stressed concrete bridge – Box Culvert-Fly over bridges

Evaluation of sub structures – Pier and abutments caps – Design of pier – Abutments – Type of foundations

Importance of Bearings – Bearings for slab bridges – Bearings for girder bridges – Electrometric bearing – Joints – Expansion joints
Construction and Maintenance of bridges – Lessons from bridge failures

1. Ponnu swamy, s., *Bridge Engineering*, Tata McGraw - Hill, New Delhi, 1997
2. Victor, D.J., *Essentials of Bridge Engineering*, Oxford & IBH Publishers Co., New Delhi, 1980.
3. N. Rajagopalan, *BridgeSuperstructure*, Narosa Publishing House, New Delhi, 2006.

CE615 THEORY OF TRAFFIC FLOW

Traffic stream parameters - Fundamental diagram of volume-speed-density surface. Discrete and continuous probability distributions. Merging manoeuvres - critical gaps and their distribution.

Macroscopic models - Heat flow and fluid flow analogies - Shock waves and bottleneck control approach.

Microscopic models - Application of queuing theory - regular, random and Erlang arrival and service time distributions - Waiting time in single channel queues and extension to multiple channels.

Linear and non-linear car following models - Determination of car following variables - Acceleration noise.

Geographical Information System – Global Positioning System – Intelligent Transportation Systems - Area Traffic Control – Automatic Toll Collection – Smart Cards – Collision Detection System.

1. Drew, D.R., *Traffic Flow Theory and Control*, McGraw Hill., 1978.
2. TRB, *Traffic Flow Theory* - A Monograph, SR165, 1975.
3. Burrough P.A. and Rachel A. McDonell, *Principles of Geographical Information Systems*, Oxford Publication, 2004.