**ANNA UNIVERSITY, CHENNAI**

**UNIVERSITY DEPARTMENTS**

**REGULATIONS – 2015**

**CHOICE BASED CREDIT SYSTEM**

**M. E. TRANSPORTATION ENGINEERING**

**PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :**

I. To prepare students to excel in research or to succeed in Transportation engineering profession through global, rigorous post graduate education.
II. To enable the students to have a strong analytical and practical knowledge of planning, designing and solving the transportation problems.
III. To introduce the recent advancements in the field of Sustainable Urban Development, Traffic Engineering and Management, Transport Planning, Highway Design & Construction, Economic and Environment Evaluation of Transport Projects.
IV. To inculcate students in professional, effective communication skills, teamwork skills, ethical and societal responsibility.
V. To provide student with an academic environment aware of excellence, leadership, written ethical codes and guidelines, continuous learning to harness evolving technologies and the life-long learning needed for a successful professional career

**PROGRAMME OUTCOMES (POs):**

On successful completion of the programme,

1. Graduates will demonstrate knowledge of mathematics, science and engineering.
2. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
3. Graduate will demonstrate an ability to design and conduct experiments, analyze and interpret data.
4. Graduate will demonstrate and apply appropriate techniques, resources, and modern engineering tools such as CAD, GIS and ITS including prediction and modeling to complex Transportation Engineering activities with an understanding of the limitations.
5. Graduate will acquire in-depth knowledge of Transportation Engineering, including wider and global perspective, with an ability to discriminate, evaluate, analyse and synthesise existing and new knowledge.
6. Graduate will analyse complex Transportation Engineering problems critically, apply independent judgement for synthesising information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
7. Graduates will demonstrate knowledge of professional and ethical responsibilities.
8. Graduate will be able to communicate effectively in both verbal and written form.
9. Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
10. Graduate will recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

| Programme Educational Objectives | Programme Outcomes | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| I | ✓ | ✓ | | ✓ | | | | | | |
| II | | | ✓ | ✓ | ✓ | | | | | |
| III | | | | ✓ | | ✓ | | | ✓ | |
| IV | | | | | | | ✓ | ✓ | | ✓ |
| V | | ✓ | | | | ✓ | | | ✓ | ✓ |

| | | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR 1 | SEM 1 | Probability and Statistical Methods | ✓ | | | | | | | | | |
| | | Traffic Engineering design and Management | | ✓ | | ✓ | ✓ | | | | | |
| | | Urban and Regional Planning | | | | | ✓ | | | | ✓ | |
| | | Pavement Design, Construction and Evaluation | | | | | ✓ | ✓ | | | | |
| | | Elective I | | | | | | | | | | |
| | | Elective II | | | | | | | | | | |
| | | Traffic Surveys and Analysis | | ✓ | ✓ | | | | | | | |
| | | | | | | | | | | | | |
| | SEM 2 | Transportation System Planning | | | | | | ✓ | | | ✓ | |
| | | Traffic Flow Theory | | | | | ✓ | ✓ | | | ✓ | |
| | | Transportation Economics | | | | | | | | | ✓ | |
| | | Elective III | | | | | | | | | | |
| | | Elective IV | | | | | | | | | | |
| | | Pavement Materials and Evaluation Laboratory | | | ✓ | | | | | | | |
| | | CAD in Transportation Engineering | | ✓ | ✓ | ✓ | | | | | | |
| | | Seminar | | | | | | | | ✓ | | |
| | | | | | | | | | | | | |
| YEAR 2 | SEM 1 | Mass Transit System Planning | | | | | ✓ | ✓ | | | | |
| | | Elective V | | | | | | | | | | |
| | | Elective VI | | | | | | | | | | |
| | | Practical Training (2 weeks) | | | | ✓ | | | ✓ | ✓ | | ✓ |
| | | Project Work Phase I | | ✓ | | ✓ | | | ✓ | | ✓ | ✓ |
| | | | | | | | | | | | | |
| | SEM 2 | Project Work Phase II | | | ✓ | ✓ | | | ✓ | | | ✓ |
| | | | | | | | | | | | | |

**ANNA UNIVERSITY, CHENNAI**

**UNIVERSITY DEPARTMENTS**

**M.E. TRANSPORTATION ENGINEERING**

**REGULATIONS – 2015**

**CHOICE BASED CREDIT SYSTEM**

**CURRICULA AND SYLLABI**

**SEMESTER I**

| S.No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | MA7159 | Probability and Statistical Methods | FC | 4 | 4 | 0 | 0 | 4 |
| 2. | TE7101 | Pavement Design, Construction and Evaluation | PC | 3 | 3 | 0 | 0 | 3 |
| 3. | TE7102 | Traffic Engineering Design and Management | PC | 3 | 3 | 0 | 0 | 3 |
| 4. | TE7103 | Urban and Regional Planning | PC | 3 | 3 | 0 | 0 | 3 |
| 5. | | Elective I | PE | 3 | 3 | 0 | 0 | 3 |
| 6. | | Elective II | PE | 3 | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | | | |
| 7. | TE7111 | Traffic Surveys and Analysis Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| | | | **TOTAL** | **23** | **19** | **0** | **4** | **21** |

**SEMESTER II**

| S.No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | TE7201 | Traffic Flow Theory | PC | 3 | 3 | 0 | 0 | 3 |
| 2. | TE7202 | Transportation Economics | PC | 3 | 3 | 0 | 0 | 3 |
| 3. | TE7203 | Transportation System Planning | PC | 3 | 3 | 0 | 0 | 3 |
| 4. | | Elective III | PE | 3 | 3 | 0 | 0 | 3 |
| 5. | | Elective IV | PE | 3 | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | | | | |
| 6. | TE7211 | CAD in Transportation Engineering Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 7. | TE7212 | Pavement Materials and Evaluation Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 8. | TE7213 | Seminar | EEC | 2 | 0 | 0 | 2 | 1 |
| | | | **TOTAL** | **25** | **15** | **0** | **10** | **20** |

**SEMESTER III**

| S.No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | TE7301 | Mass Transit System Planning | PC | 3 | 3 | 0 | 0 | 3 |
| 2. | | Elective V | PE | 3 | 3 | 0 | 0 | 3 |
| 3. | | Elective VI | PE | 3 | 3 | 0 | 0 | 3 |
| **PRACTICALS** | | | | | | | | |
| 4. | TE7311 | Practical Training (2 weeks) | EEC | 0 | 0 | 0 | 0 | 1 |
| 5. | TE7312 | Project Work (Phase I) | EEC | 12 | 0 | 0 | 12 | 6 |
| | | | **TOTAL** | **21** | **9** | **0** | **12** | **16** |

**SEMESTER IV**

| S.No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **PRACTICALS** | | | | | | | | |
| 1. | TE7411 | Project Work (Phase II) | EEC | 24 | 0 | 0 | 24 | 12 |
| | | | **TOTAL** | **24** | **0** | **0** | **24** | **12** |

**TOTAL NO. OF CREDITS: 69**

## FOUNDATION COURSES (FC)

| S.No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | | Probability and Statistical Methods | FC | 4 | 4 | 0 | 0 | 4 |

## PROFESSIONAL CORE (PC)

| S.No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | | Traffic Engineering design and Management | PC | 3 | 3 | 0 | 0 | 3 |
| 2. | | Urban and Regional Planning | PC | 3 | 3 | 0 | 0 | 3 |
| 3. | | Pavement Design, Construction and Evaluation | PC | 3 | 3 | 0 | 0 | 3 |
| 4. | | Traffic Surveys and Analysis Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 5. | | Transportation Systems Planning | PC | 3 | 3 | 0 | 0 | 3 |
| 6. | | Traffic Flow Theory | PC | 3 | 3 | 0 | 0 | 3 |
| 7. | | Transportation Economics | PC | 3 | 3 | 0 | 0 | 3 |
| 8. | | CAD in Transportation Engineering Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 9. | | Pavement Materials and Evaluation Laboratory | PC | 4 | 0 | 0 | 4 | 2 |
| 10. | | Mass Transit System Planning | PC | 3 | 3 | 0 | 0 | 3 |

## PROFESSIONAL ELECTIVES (PE)

| S.No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | TE7001 | Advanced System Dynamics Modeling in Transportation Engineering | PE | 3 | 3 | 0 | 0 | 3 |
| 2. | TE7002 | Airport System Planning and Design | PE | 3 | 3 | 0 | 0 | 3 |
| 3. | TE7003 | Computational Techniques in Transportation Engineering | PE | 3 | 3 | 0 | 0 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4. | TE7004 | Environmental Impact Assessment of Transportation Projects | PE | 3 | 3 | 0 | 0 | 3 |
| 5. | TE7005 | Geospatial Techniques | PE | 3 | 3 | 0 | 0 | 3 |
| 6. | TE7006 | Intelligent Transportation Systems | PE | 3 | 3 | 0 | 0 | 3 |
| 7. | TE7007 | Logistics in Transportation Engineering | PE | 3 | 3 | 0 | 0 | 3 |
| 8. | TE7008 | Pavement Management System | PE | 3 | 3 | 0 | 0 | 3 |
| 9. | TE7009 | Rail Transportation Systems – Planning and Design | PE | 3 | 3 | 0 | 0 | 3 |
| 10. | TE7010 | Road Safety System | PE | 3 | 3 | 0 | 0 | 3 |
| 11. | TE7011 | Sustainable Urban and Transport Development | PE | 3 | 3 | 0 | 0 | 3 |
| 12. | TE7012 | Transportation Modeling and Simulation | PE | 3 | 3 | 0 | 0 | 3 |
| 13. | TE7013 | Urban Infrastructure and Asset Management. | PE | 3 | 3 | 0 | 0 | 3 |
| 14. | TE7014 | Waterways Transportation System – Planning and Design | PE | 3 | 3 | 0 | 0 | 3 |

## EMPLOYABILITY ENHANCEMENT COURSES (EEC)

| S.No | COURSE CODE | COURSE TITLE | CATEGORY | CONTACT PERIODS | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | | Seminar | EEC | 2 | 0 | 0 | 2 | 1 |
| 2. | | Practical Training (2 Weeks) | EEC | - | - | - | - | 1 |
| 3. | | Project Work (Phase I) | EEC | 12 | 0 | 0 | 12 | 6 |
| 4. | | Project Work (Phase II) | EEC | 24 | 0 | 0 | 24 | 12 |

**MA7159 PROBABILITY AND STATISTICAL METHODS L T P C**
**4 0 0 4**

**OBJECTIVES:**

- To introduce the basic concepts of one dimensional and two dimensional Random Variables.
- To provide information about Estimation theory, Correlation, Regression and Testing of hypothesis.
- To enable the students to use the concepts of multivariate normal distribution and principle components analysis.

**UNIT I ONE DIMENSIONAL RANDOM VARIABLES 12**

Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a Random Variable.

**UNIT II TWO DIMENSIONAL RANDOM VARIABLES 12**

Joint distributions – Marginal and Conditional distributions – Functions of two dimensional random variables – Regression Curve – Correlation.

**UNIT III ESTIMATION THEORY: 12**

Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation - Curve fitting by Principle of least squares – Regression Lines.

**UNIT IV TESTING OF HYPOTHESES: 12**

Sampling distributions - Type I and Type II errors - Tests based on Normal, t, Chi-Square and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

**UNIT V MULTIVARIATE ANALYSIS: 12**

Random Vectors and Matrices - Mean vectors and Covariance matrices - Multivariate Normal density and its properties - Principal components: Population principal components – Principal components from standardized variables.

**TOTAL: 60 PERIODS**

**OUTCOMES:**

- The course aims at providing the basic concepts of Probability and Statistical techniques for solving mathematical problems which will be useful in solving Engineering problems.

**TEXTBOOKS:**


1. Jay L. Devore, “Probability and statistics for Engineering and the Sciences”, Thomson and Duxbury, Singapore, 2002.
2. Richard Johnson. ”Miller & Freund’s Probability and Statistics for Engineer”, Prentice – Hall of India, Private Ltd., New Delhi, Seventh Edition, 2007.
3. Richard A. Johnson and Dean W. Wichern, “Applied Multivariate Statistical Analysis”, Pearson Education, Asia, Fifth Edition, 2002.


**REFERENCES:**


1. Gupta S.C. and Kapoor V.K.”Fundamentals of Mathematical Statistics”, Sultan and Sons,New Delhi, 2001.
2. Dallas E Johnson et al., “Applied multivariate methods for data analysis”, Thomson and Duxbury press, Singapore, 1998.

**TE7101 PAVEMENT DESIGN, CONSTRUCTION AND EVALUATION** **L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To understand the properties and use of various materials and construction
- To study the behaviour of pavements under various loads.
- To design the flexible and rigid pavements using different Empirical, semi-empirical and theoretical approaches
- To understand the concept of Pavement Management System, pavement failures and its evaluation

**UNIT I PAVEMENT MATERIALS 9**

Soil in subgrade, subbase and unstabilised base- Basic engineering properties- Soil stabilization-different methods- Use of geosynthetics – Requirements and desirable properties of aggregates- Bituminous binders- emulsion and modified bitumen- Properties, testing and applications- Superpave concept, Bituminous mixes -Design, testing and evaluation-new materials like polymer modified bitumen, geo synthetics- modern materials in pavements.

**UNIT II PAVEMENT CONSTRUCTION 9**

Earthwork – roadway excavation, embankment construction- Subbase – Construction of gravel and stabilized bases; Base – WBM base, wet mix macadam; Bituminous pavements – preparation & laying of tack coat, bituminous macadam, mixed seal surfacing, bituminous concrete; Cement concrete pavements – construction methods of cement concrete roads, joints in plain and reinforced cement concrete pavements –Drainage – Estimation of flow, surface drainage, sub-surface drainage systems- -different types of drains-Pavement Recycling.

**UNIT III DESIGN OF FLEXIBLE PAVEMENTS 9**

Factors affecting design and performance - Stresses and deflection in homogenous masses, Burmister's 2 layer, 3 layer and multi-layer theories, wheel load stresses, ESWL, pavement behavior under transient traffic loads, problems on above.CBR method, principle, advantages and application, testing as per IRC, AASHTO, and asphalt institute, problems on above.

**UNIT IV DESIGN OF RIGID PAVEMENTS 9**

Factors affecting design and performance, types of stresses, causes and factors affecting stresses,EWL, Westergaard's analysis, Bradbury's coefficient, wheel load stresses, warping-frictional-combined stresses, problems on above. - Types of Joints in Cement Concrete Pavements and their Functions-IRC design chart, design of longitudinal, contraction and expansion joints, and design of slabs.

**UNIT V PAVEMENT EVALUATION AND MAINTENANCE 9**

Failures in pavements- methods of measurement of skid resistance, unevenness, ruts and cracks. Pavement surface condition evaluation by physical measurements methods and their application, Calculation of IRI values - devices adopted - Measurement of profile- tolerance standards in quality control- - waves and deformations-Measurements- rebound deflection roughness index- effect of traffic, fuel, chemicals and environmental conditions - Assessing structural strength of highway and airport pavements- Serviceability, structural number and energy concepts- need for conditioning and strengthening -maintenance strategies evaluation by non-destructive tests- Benkelman beam method, overlay design, pavement serviceability concepts, maintenance measures- short term and long term.

**TOTAL : 45 PERIODS**

**OUTCOME:**

- The students would have gained knowledge on the Material properties, Design, Evaluation and Management of Pavement Systems.

**REFERENCES:**


1. Yoder and Witczak, *Priniciples of Pavement Design*, John Wiley and Sons.
2. Alkins and Harold, "Highway Material" , Prentice Hall, Pearson, 2003.
3. Kerbs and Walkes, "Highway Materials", McGraw Hill Book Co.2007.
4. Specifications for" Road and Bridge works", Fourth Revision, MoSRT&H(India), 2001 .
5. Peurify.R.L., "Construction Planning, Equipment and Methods", McGraw Hill Publishers, New York, 2000.
6. S.C.Sharma., "Construction Equipment and its Management", Khanna Publishers, New Delhi, 1988.
7. Yang H. Huang, "Pavement Analysis and Design", Prentice Hall, New Jersy,1993
8. Ralph Haos, "Ronald Hudson and Zaniesuki, Modern Pavement Management", Kneigr Publications, 1994
9. Relevant IRC Codes


**TE7102 TRAFFIC ENGINEERING DESIGN AND MANAGEMENT L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To be aware of various methods of collecting traffic data.
- To understand the basics of highway planning and design, and workout problems in design of road geometrics.
- Provides a basic understanding on Traffic Engineering – Planning, Design, Operation and Management

**UNIT I TRAFFIC CHARACTERISTICS 9**

Physical, Physiological, Psychological, Environmental Characteristics, Traffic Stream Characteristics, Vehicle Characteristics – Static and Dynamic, Urban Road and Road Characteristics – Geometric Design- Overview.

**UNIT II SURVEYS AND STUDIES IN TRAFFIC ENGINEERING 9**

Conventional and Modern Methods of Traffic Survey and Studies – Volume and Capacity – LOS for uninterrupted traffic flow – Headway concepts and applications – Speed and Delay – Origin and Destination, Parking, Accident – Level of Service (LoS)

**UNIT III DESIGN OF TRANSPORT INFRASTRUCTURE 9**

Design of roads – Design Speed, Terrain, Gradient curves – Horizontal and Vertical, Superelevation, Sight Distance – Stopping Sight Distance, Overtaking Sight Distance, Traffic Sign, Road Markings, Traffic Control Aids, Street furniture, Road Arboriculture

**UNIT IV INTERSECTION DESIGN AND ANALYSIS 9**

Design of Intersection – At grade intersection – Uncontrolled, Channelisation, Rotary, Traffic Signal Control, Signal Co-ordination, Grade Separated Intersection - Types ,Design and Analysis.

**UNIT V TRAFFIC OPERATION AND MANAGEMENT 9**

Traffic Regulation, Cost Effective Management Measures – Traffic Systems Management and Travel Demand Management - Congestion Management, Traffic Calming and Pricing-Design of Cycle Tracks, Pedestrian Facilities, Parking Facilities – On Street, Off Street Multi level car Parking - Street Lighting.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Students would be aware of the basic Principles and Design, Planning and Management of Transportation system.

**REFERENCES:**


1. Wolfgang S. Homburger et.al., „Fundamentals of Traffic Engineering" 15th Edition, Institute of Transportation Studies, University of California, Berkely, 2001
2. James L. Pline (Edr) „Traffic Engineering Hand Book", Institute of Transportation Engineers,
3. Nicholas T.Garber, Lester A Hoel, „Traffic and Highway Engineering", Revised Second Edition, ITP, California, USA, 1999
4. Thomas Curinan, „An Introduction to Traffic Engineering – A Manual for Data Collection and
5. Analysis, Books Cole, UK, 2001
6. Kadiyali, L.R., „Traffic Engineering and Transport Planning", Khanna Publishers, Delhi, 2006.
7. Washington DC, USA, 1999Pignataro, L.J., Traffic Engineering – Theory & Practice, John Wiley, 1985.
8. AASHTO A Policy on Geometric Design of Highway and Streets


**TE7103 URBAN AND REGIONAL PLANNING L T P C**
**3 0 0 3**

**OBJECTIVES:**

- Provides a basic knowledge on Urbanization and its trend.
- Deals with different types of plan, its implementation, regional development and management for sustainable Urban growth.

**UNIT I BASIC CONCEPTS POLICIES AND PROGRAMMES 8**

Definitions and Concept- Urbanization, Towns, Cities, Metropolis, Megalopolis, Satellite and New towns, CBD, Peri urban areas, Suburban areas, Census Definition, Classification of urban settlements, TOD, National policies, National Urban Transport Policy 2006, National Policy for Urban street vendors 2009- Programme objectives and salient features of Jawaharlal Nehru National Urban Renewal Mission (JNNURM), Urban infrastructure development scheme for small and medium towns (UIDSSMT), Rajiv Awas Yojana (RAY),

**UNIT II PLANNING PROCESS 8**

Steps in Planning Process- Plans; levels; objectives, content, and data requirement-regional plan, master plan, detail development plan, city development plan, development control regulation, Zoning Regulation, Layout and Building Regulations.

**UNIT III SOCIO ECNOMIC AND SPATIAL PLANNING 10**

Economic and social concepts in urban and regional planning and their relevance, Economic principals of zoning, Components of sustainable development, Inclusive development, Compact cities, Quality of life-Form of cities, issues related to inner city fringe areas, and suburban areas, Application of Remote sensing and GIS in Urban and Regional planning.

**UNIT IV PROJECT FORMULATION AND EVALUATION 10**

Constraints for plan implementation – Industrial, Financial and Legal Constraints, Institutional Arrangements for Urban Development – Financing of Urban Developments - Legislation related to Urban Development. Urban infrastructure projects planning, appraisal, formulation, feasibility and preparation of detailed project report, site planning, layout, road network, and service ducts under the road, Environmental impact assessment, and Traffic assessment.

**UNIT V URBAN GOVERNANCE AND MANAGEMENT 9**

Planning laws; Town and Country planning act: Urban Development authorities Act, Constitutional (74th Amendment) Act 1992- Local bodies, Functions, powers and Interfaces-development of small town and smart cities-case studies

**TOTAL: 45 PERIODS**

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Students will be aware of various Acts, Policies and Programmes related to Urban Planning and Development.
- Students will be in a position to formulate, appraise and conduct feasibility studies on urban projects

**REFERENCES:**

1. CMDA, Second Master Plan for Chennai, Chennai 2008
2. Goel, S.L Urban Development and Management, Deep and Deep publications, New Delhi 2002
3. George Chadwick, "A Systems view of planning", Pergamon press, Oxford 1978
4. Singh V.B, "Revitalised Urban Administration" in India, Kalpaz publication, Delhi 2001
5. Edwin S.Mills and Charles M.Becker, "Studies In Urban Development", A World Bank Publication, 1986
6. Thooyavan. K.R, "Human Settlements – A Planning Guide to Beginners. M.A Publications, Chennai 2005.
7. Tumlin Jeffrey, "Sustainable Transportation Planning Tools for Creating Vibrant Healthy and Resilient Communities", John Wiley And Sons, 2012.

**TE7111 TRAFFIC SURVEYS AND ANALYSIS LABORATORY L T P C**
**0 0 4 2**

**OBJECTIVE:**

- Provides clear understanding on conducting various types of traffic surveys data collection, analysis, inference and presentation

**LIST OF EXERCISES:**

Conduct of the following surveys related to Transport Development, Analysis, Inferences and Proposals.

1. Volume count
2. Spot speed
3. Speed and delay studies
4. Parking studies
5. Origin and destination studies
6. Physical inventory using total station survey equipment.
7. Environmental impact – Noise studies and vehicular emission measurement
8. Lighting studies

**TOTAL : 60 PERIODS**

**OUTCOME:**

- The students would have an understanding on conducting various types of traffic surveys involving data collection its analysis and the inference and way of presentation.

| TE7201 | TRAFFIC FLOW THEORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE:**

- To impart knowledge in Traffic Flow Characteristics, Flow Modeling and Computer Simulation

**UNIT I TRAFFIC FLOW FUNDAMENTALS 10**

Fundamentals of Traffic Flow – Flow Parameters – Nature of traffic flow – Approaches to Traffic Flow - Spacing, Gap and Headway Characteristics – Probabilistic aspects of Traffic Flow – Various Distributions – Gap acceptance – Vehicle arrival studies.

**UNIT II TRAFFIC FLOW CHARACTERISTICS 10**

Traffic Flow characterization – Categories of Traffic Flow – Macroscopic and Microscopic Traffic Flow Models – Centrally versus Individually controlled modes – Vehicular Stream Models - Lighthill and Withams Theory – Application of theory to deal bottlenecks – Trajectory Diagrams – Shock waves – Propagation and equation – Greenbergs extension of law of continuity – Car Following theory.

**UNIT III QUEUING MODELS 8**

Queuing Theory – Types of Queuing Model – Queuing Characteristics and Behaviour – Transition-Diagram – Queuing Cost Model Application to Traffic Engineering

**UNIT IV TRAFFIC DELAYS 8**

Delay at Intersections - Type of delays - Manual measurement – Saturated and oversaturated intersections – Arrival Pattern

**UNIT V INTELLIGENT TRANSPORT SYSTEM 9**

Introduction to Intelligent Transportation Systems (ITS)- The Range of ITS Applications -Network Optimization-Sensing Traffic using Virtual Detectors- In-Vehicle Routing, and Personal route information-The Smart Car-Commercial Routing and Delivery-Electronic Toll Collection-The Smart Card-Dynamic Assignment- Traffic Enforcement.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Students would have knowledge of Traffic Flow characteristics and the theory of Traffic Flow that would help them to develop an efficient transport system.

**REFERENCES:**


1. Drew, D.R., "Traffic Flow Theory and Control", McGraw Hill, NewYork,1968
2. Highway Capacity Manual, Special Report 209, Transportation Research Board (TRB), National Research Council, Washington DC,1988
3. May A.D., "Traffic Flow Fundamentals", Prentice Hall Inc., New Jersey,1990
4. Papacostas C.S., Prevedouros, "Transportation Engineering and Planning", 3rd Edition, Prentice Hall of India, New Delhi, 2002
5. TRB, Traffic Flow Theory - A Monograph, SR165, 1975.
6. Kadiyali, L.R, "Traffic Engineering and Transport Planning", Khanna Publishers, Delhi,2006.

**TE7202 TRANSPORTATION ECONOMICS L T P C**
**3 0 0 3**

**OBJECTIVE:**

- Provides knowledge in economic evaluation and Public private partnership in developing road infrastructure projects and application of systems simulation techniques in modeling transport economic systems.

**UNIT I ECONOMIC EVALUATION 9**

Need for Economic Evaluation of Urban Transport Projects – Principles of Economic Analysis – Methods of Economic Evaluation – Comparison of various methods – Application of Simulation Modeling in evolving suitable evaluation techniques – Sensitivity Analysis.

**UNIT II MODELING OF ROAD USER COSTS 8**

Components of vehicle operating cost – Factors affecting vehicle operating cost – Value of Travel Time Saving - Accident Cost – Concept of Route Switching Mechanism. - Ripple effects in developing new infrastructure – Simulation Modeling exercise.

**UNIT III TRANSPORT DEMAND SUPPLY CONCEPT 8**

Transport demand and supply concepts - Status of transport demand supply in metropolitan cities – Demand and Supply equilibrium - Subsidy in Transport demand – Supply augmentation and saturation consideration- simulation modeling of transport demand and supply for sustainability.

**UNIT IV TRANSPORT PRICING 10**

Transport costs – Elasticity of demand – Average cost and Marginal cost pricing – Market Pricing and Market Segmentation – Second best pricing – Pricing Policy – Congestion Pricing – Public and Private Transport Pricing – Price Co-ordination- ERP

**UNIT V FINANCING TRANSPORT SYSTEM 10**

Characteristics of Transportation Infrastructure – Trends in Transportation Infrastructure – Investment Needs, Options and Budgetary Support in Transport Sector – Existing Financing Practices – Principles of Build, Operate and Transfer (BOT) –BOT variants and its applicability– Special Purpose Vehicles-Alternative Financial Resources.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Students would be equipped with the economic principles in dealing with transport supply and demand.

**REFERENCES:**


1. Robert F Baker, (eds), "Hand Book of Highway Engineering, Van Nostrand Reinhold Company, New York, 1975
2. Indian Roads Congress Standards, "Economic Evaluation of Transport Projects", New Delhi, 2002
3. John Khisty C, Kent Lall B, "Transportation Engineering – An Introduction, 3rd Edition, Prentice Hall of India, New Delhi, 2002
4. Hanspeter George; "Cost Benefit Analysis and Public Investment in Transport" – A Survey Butterworths, London, 1973
5. The Institution of Engineers India , "Proceedings of the National Seminar on Infrastructure Development" – Strategies for Transportation Sector, New Delhi. 1997

**TE7203 TRANSPORTATION SYSTEMS PLANNING L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To impart knowledge in the rudiments and advancements in Transportation Planning and Travel Demand Forecasting

**UNIT I TRANSPORTATION SYSTEM STATUS 9**

Status of existing Transportation System – Systems Approach to Transport Planning - Interdependence of the Landuse and Traffic – Stages in Transportation Planning – Transport Systems and Planning Considerations. Concepts of Zoning – O-D Surveys – Inventory of Transport and other activities – TravelForecasting Process -Forecasting Process - Critical issues in Travel forecasting – Basics of Systems Simulation Modeling.

**UNIT II TRIP GENERATION AND DISTRIBUTION 9**

Trip Generation Models-Trip classification - productions and attractions – Trip rate analysis - Multiple regression models - Category analysis - Trip distribution models – Growth factor models, Gravity model and Opportunity modes

**UNIT III MODAL SPLIT 9**

Modal split models – Mode choice behavior – Trip end and trip interchange models - Probabilistic models - Utility functions - Logit models - Two stage model.

**UNIT IV TRAFFIC ASSIGNMENT 9**

Traffic assignment – Transportation networks – Minimum Path Algorithms - Assignment methods – All or Nothing assignment, Capacity restrained assignment and Multi path assignment - Route-choice behavior.

**UNIT V LAND USE TRANSPORT MODEL (LUT) 9**

Accessibility Measures and Basic Theories – Lowry Derivatives Model- Garin Model –Approach and Simulation Modeling in LUT Model - Multimodal Transportation Planning.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Students would be aware of the Principles and Planning of Transportation Infrastructure.

**REFERENCES:**


1. Konstadinos G. Goulias 'Transportation Systems Planning: Methods and Applications' CRC Press, Taylors and Frances Group.
2. Ennio Cascetta 'Transportation Systems Analysis: Models and Applications' 2nd Edition, Springer New York.
3. John Khisty C, Kent Lall B, "Transportation Engineering – An Introduction, 3rd Edition, Prentice Hall of India, New Delhi, 2002
4. Papacostas C.S., Prevedouros, "Transportation Engineering and Planning, 3rd Edition, Prentice Hall of India, New Delhi, 2002
5. John D.Edwards (Edr.), "Transportation Planning Hand Book", 2nd Edition, Institute of Transportation Engineers, Prentice Hall Inc.,, Washington DC, USA, 1999
6. Chennai Metropolitan Development authority (CMDA) (2006), Chennai Metropolitan Area – Second Master Plan, Chennai.
7. Chennai Metropolitan Development authority (CMDA) (2008) – Chennai Comprehensive Transportation study.

**TE7211 CAD IN TRANSPORTATION ENGINEERING LABORATORY L T P C**
**0 0 4 2**

**OBJECTIVE:**

- Helps in formulation and evaluation of Transportation Engineering projects using software

**COURSE CONTENT**

1. Transportation Software – VISSIM, CUBE, TRANSCAD, TRANSYT Mx Road, HDM4,
2. GIS and Remote Sensing Packages – ArcGIS, Geo-Concept, GPS
3. Development of Application programs using C/C++.
4. Computer Aided Drafting - DBMS concepts - Civil Engineering Databases – Data entry & Reports. Spreadsheet concepts – Worksheet calculations in Civil Eng, - Regression & Matrix Inversion, SPSS.

**TOTAL : 60 PERIODS**

**OUTCOME:**

- The students would have gained knowledge on various Transportation software tools and their application in solving transportation problems on a real time basis.

**TE7212 PAVEMENT MATERIALS AND EVALUATION LABORATORY L T P C**
**0 0 4 2**

**OBJECTIVE:**

- To give the students to hands on experience on the various testing procedures of pavement materials as per the IRC standards.

**I PAVEMENT MATERIAL TESTING**

- Test on Soil
- Tests on Road Aggregates.
- Testing on Bitumen

**II TESTS ON BITUMINOUS MIXTURE.**

- Design of Bituminous Mixes.
- Marshal Stability Test.

**III PAVEMENT EVALUATION – ROUGHNESS AND DISTRESS EVALUATION**

- Visual pavement condition survey - patches, potholes, ravelling, edge breaking and cracking.
- Skid resistance measurements.
- Texture Depth.
- MERLIN
- Benkelman Beam Deflection test.

**TOTAL : 60 PERIODS**

**OUTCOME:**

- The students on completion of the laboratory classes would have knowledge on properties and testing procedures of pavement materials.

**TE7213** **SEMINAR** **L T P C**
**0 0 2 1**

**OBJECTIVES:**

- To work on a specific technical topic in Transportation Engineering in order to acquire the skills of oral presentation.
- To acquire technical writing abilities for seminars and conferences.

**TOTAL : 30 PERIODS**

**SYLLABUS:**

The students will work for two hours per week guided by a group of faculty members. They will be asked to select on any topic of their choice related to transportation engineering. Students are asked to submit the brief report of their seminar topic. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will also answer the queries on the topic. The students as audience also should interact. Evaluation will be based on the technical presentation and the report and also on the interaction during the seminar.

**TE7301** **MASS TRANSIT SYSTEM PLANNING** **L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To identify the role of various modes of Mass Transportation like Bus and Rail and its Planning and Management

**UNIT I TRANSIT SYSTEM AND ISSUES 6**

Introduction to Mass Transport – Role of various modes of Mass Transport – Problems and their Impact – Transport System Performance at National, State, Local and International levels – National Transport Policy

**UNIT II PUBLIC TRANSIT SYSTEM 9**

Urban Transport System – Public Transport System Re-genesis and Technology – Physical performance of Public Transport System – Public Transport and Urban Development Strategies - Characteristics of Rail Transit – Vehicle Characteristics, ITS, Para transit systems - Intermediate Public Transport.

**UNIT III BUS TRANSIT PLANNING AND SCHEDULING 10**

Route Planning and Scheduling – Bus Transport System – Performance and Evaluation – Scheduling – Conceptual patterns of bus service – Network Planning and Analysis – Bus Transport System Pricing – Bus Transit System Integration – Analytical Tools and Techniques for Operation and Management – Bus Rapid Transit Systems – Case Studies

**UNIT IV RAIL TRANSIT TERMINALS AND PERFORMANCE EVALUATION 10**

Performance Evaluation – Efficiency, Capacity, Productivity and Utilisation – Performance Evaluation Techniques and Application – System Network Performance – Transit Terminal Planning and Design- Urban Rail Transit Planning – MRTS – LRTS, Metro Rail – Monorail – Network Design, Capacity and Traffic Fore casting - Case Studies

**UNIT V IMPACT OF TRANSIT 10**

Policies and Strategies for Mass Transport – Need for Integrated Approach – Unified Transport Authorities – Institutional arrangement – Urban Transport Fund – Parking Policies - Private Sector in Mass Transport – Bus and Rail Integration – Co-ordination of Feeder Services – Transit Oriented Land Use Development – Case Studies - Urban Transportation and Land use – Impact of Transport Development on Environment – Remedial measures – Policy Decisions – Recent Trends in Mass Transportation Planning and Management

**TOTAL: 45 PERIODS**

**OUTCOME:**

- The students would have knowledge on planning of various transit systems like bus and rail, their scheduling and management strategies.

**REFERENCES:**


1. Michael J. Bruton , "An Introduction to Transportation Planning", Hutchinson,1985
2. Michael D. Meyer and Eric J.Miller , "Urban Transportation Planning – A Decision Oriented Approach", McGraw Hill Book Company, New York,1984
3. Hobbs F.D, "Traffic Planning and Design", Poargamon Oress
4. John W. Dickey, "Metropolitan Transportation Planning" – Tata McGraw Hill Publishing Company Limited, New Delhi, 1980
5. Paul H. Wright, "Transportation Engineering – Planning and Design", John Wiley and Sons, New York, 1989.


**TE7311 PRACTICAL TRAINING (2 Weeks) L T P C**
**0 0 0 1**

**OBJECTIVES:**

- To train the students in the field work so as to have a firsthand knowledge of practical problems related to Transportation Engineering.
- To develop skills in facing and solving the problems experiencing in the field.

**SYLLABUS:**

The students individually undertake training in reputed engineering companies doing transportation projects during the summer vacation for a specified duration of four weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal faculty members.

**TE7312 PROJECT WORK (PHASE I) L T P C**
**0 0 12 6**

**OBJECTIVES:**

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

**SYLLABUS:**

The student individually works on a specific topic approved by the Head of the Division under the guidance of a faculty member who is familiar in this area of interest. The student can select any topic which is relevant to the area of Transportation Engineering. The topic may be theoretical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

**TOTAL: 180 PERIODS**

**OUTCOME:**

- At the end of the course the students will have a clear idea of his/her area of work and they are in a position to carry out the remaining phase II work in a systematic way.

| TE7411 | PROJECT WORK (PHASE II) | L T P C<br>0 0 24 12 |
|---|---|---|

**OBJECTIVES:**

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

**SYLLABUS:**

The student should continue the phase I work on the selected topic as per the formulated methodology under the same supervisor. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the Head of the Department. The students will be evaluated through based on the report and the viva-voce examination by a panel of examiners including one external examiner.

**TOTAL: 360 PERIODS**

**OUTCOME:**

- On completion of the project work students will be in a position to take up any challenging practical problems in the field of transportation engineering and find better solutions to it.

| TE7001 | ADVANCED SYSTEM DYNAMICS MODELING IN TRANSPORTATION ENGINEERING | L T P C<br>3 0 0 3 |
|---|---|---|

**OBJECTIVE:**

- To provide advanced level of knowledge in System Dynamics Modeling in Transportation Engineering

**UNIT I COMPLEXITY AND SYSTEMS THINKING 8**

Change – Complexity and Interdependency – Systems thinking – Floundering – Level of abstractions- Tools and Transitions in Systems Thinking – Synthesis and Organisational Learning

**UNIT II ADVANCED MODELING EFFORTS 8**

Steady State Modeling – Discrete vs. Continuous – Generic infrastructures –Subsystems – Sensitivity parametering - Case Studies

**UNIT III ADVANCED SIMULATING TECHNIQUES 10**

Graphical Bulletin function – Conveyor flows – Converter – Flow substitutes – Connector – Normalising Inputs – Generic flow activities – Case Studies

**UNIT IV MODELING PROCESS 10**

System Dynamics Modeling challenges – Steps in Modeling Process – Guidelines – Model Boundary– Modeling soft variables – Quantification vs. Measurement

**UNIT V SOPHISTICATED DYNAMICS MODELING 9**

Need – Isolation Process – Demand Expansions – Cycle functions – Sensitivity Analysis – Alternative view of Dynamic Modeling

**TOTAL: 45 PERIODS**

**OUTCOME:**

- The students would have gained knowledge the simulation techniques in System Dynamics Modeling in Transportation Engineering

**REFERENCES:**


1. Pratab Mohapatra K.J. et al., "Introduction to System Dynamics Modeling", University Press, Hyderabad, 1994
2. Thirumurthy A.M., Environmental Facilities and Urban Development in India – A System Dynamics Model for Developing Countries, Academic Foundations, India, 1992
3. Umadevi, G, Land Use Transport Interaction Modeling – A Systems Approach, Ph.D thesis, Division of Transportation Engineering, College of Engineering, Guindy, Anna University, Chennai, 2001
4. Technical Manual on An Introduction to Systems Thinking – STELLA Research Software, High Performance Systems Inc., Hannover, 1996
5. Advanced Manual on An Introduction to Systems Thinking – STELLAII Research Software, High Performance Systems Inc., Hannover, 2002


**TE7002 AIRPORT SYSTEM PLANNING AND DESIGN L T P C**
**3 0 0 3**

**OBJECTIVE:**

- Provides a basic understanding on Airport Systems Planning and Operation

**UNIT I AIRPORT PLANNING 10**

Planning of airports and its impact on metropolitan city development– Accessibility – Transport Connections – Road and Rail, Expansion – Feasibility Studies – Environmental and Social Issues – Forecasting Future Traffic – Airfield Capacity and Delay - Aircraft characteristics – Airport Site Selection

**UNITII AIRPORT COMPONENTS 10**

Airport Classification, Planning of Airfield Components – Runway, Taxiway, Apron, Hangar-Passenger Terminals- Geometric design of runway and taxiways-Runway pavement Design-Difference between Highway and airport pavements- Introduction to various design methods-Airport drainage.

**UNIT III AIRPORT PLANNING AND AIRLINE ECONOMICS 9**

Demand driven dispatch – Airline Fleet Planning Models – Network Revenue Management – Airport Performance, Slot Issues, Hub Operation, Demand Management, Multi-airport Systems- Pricing – Privatization and Deregulation, Willingness to pay and Competitive Revenue Management

**UNIT IV PASSENGER CHOICE, SCHEDULING AND FLEET ASSIGNMENT 7**

Load Factor Analysis, Airline Schedule Development, Introduction to PODS Passenger Choice Models, Decision Window Model, Fleet Assignment

**UNIT V CASE STUDIES 9**

Multi airport system – location of airport with respect to urban growth- case studies.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Students would have understood the basics of air route Planning, Network revenue Management.

**REFERENCES:**


1. Robert Honjeff and Francis X.Mckelvey, "Planning and Design of Airports", McGraw Hill, New York, 1996
2. Richard De Neufille and Amedeo Odoni, "Airport Systems Planning and Design", McGraw Hill, New York, 2003
3. Airport Planning and Systems – http://airportssystems.com/Course/index-html
4. .Khanna S.K and .Arora M.G, "Airport Planning and Design", Nem Chand and Bros, 1999.
5. Norman.J.Ashford, Sakleh.A Mumayiz and Paul.H.Wright, "Airport Engineering Planning Design and Development of 21st Century Airports, John Wiley and sons, New Jersey, 2011.


**TE7003 COMPUTATIONAL TECHNIQUES IN TRANSPORTATION ENGINEERING L T P C**
**3 0 0 3**

**OBJECTIVES**

- To be introduced to systems approach.
- To learn the fundamentals of simulation and the GPSS language.
- To be introduced to advanced computational techniques such as GA and ANN.

**UNIT I INTRODUCTION 9**

Introduction to systems approach - Typical transportation systems - Mathematical models. Fundamentals of simulation - Monte Carlo method - Continuous and discrete models - Simulation languages. Probability concepts - Random numbers - Pseudo random generators - Arrival patterns - Service time distributions – Manual simulation of simple queuing system

**UNIT II FUNDAMENTALS OF SIMULATION 9**

GPSS Fundamentals - Creating and moving transactions - Queues and facilities - Event scheduling – Standard numerical attributes – Parameters and save values - Functions - Priority - Preemption - Collection of statistics - Report preparation. Internal logic of GPSS processor - Program control statements.

**UNIT III APPLICATION OF SIMULATION CONCEPTS 9**

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.

**UNIT IV APPLICATION OF GENETIC ALGORITHM IN SIMULATION 9**

Genetic Algorithm - Terminology in GA – Strings, Structure, Parameter string - Data Structures – Operators - Algorithm – Application in Transportation. Fuzzy Logic.

**UNIT V APPLICATION OF ARTIFICIAL NEURAL NETWORKS IN SIMULATION 9**

Artificial Neural Networks - Basics of ANN – Topology - Learning Processes - Supervised and unsupervised learning. Least mean square algorithm, Back propagation algorithm - Applications.

**TOTAL: 45 PERIODS**

**OUTCOME:**

Upon completion of this course, the students should have:

- a working knowledge of simulation and GPSS programming.
- a good understanding of GA applications
- the ability to apply ANN

**REFERENCES:**


1. Gordon, G., *System Simulation,* Prentice-Hall of India, 2005
2. GPSS/PC, *User Manual, Minuteman Software,* USA, 2005
3. David E. Goldberg, Genetic Algorithms in Search, Optimisation and Machine Learning, Addison-Wesley, 1989
4. Zurada J.M. , .Introduction to artificial neural systems., Jaico Publishers, 2006


**TE7004 ENVIRONMENTAL IMPACT ASSESSMENT OF TRANSPORTATION PROJECTS**

**L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To expose the students to the need, methodology, documentation and requirements of environmental and social impact assessment of Transportation Projects.

**UNIT I ENVIRONMENTAL REGULTIONS AND EIA 10**

Laws concerned with protection of the environment such as Environmental Protection Act, Air and Noise Pollution Act, Motor Vehicle Act, Town and Country Planning Act, Development Control Regulation, Coastal Regulation Zone - Ambient Air Quality and noise Standards - EIA in Project Cycle- Impact of Traffic and transport on Environment-EIA Notification- EIA process and terms of reference for EIA of transportation Projects.

**UNIT II ENVIRONMENTAL IMPACT INDENTIFICATION AND PREDICTION 10**

Vehicle and Traffic Noise, Ambient Noise Level, Heath Effects, Vibration – Damage to building, Exhaust Emission –Measurement of Air and Noise Pollution- Air Pollution effects on Human being, Vegetation and Animals -Data analysis and Prediction of Pollution and Impact Data – Line source emission modeling– Noise pollution prediction.

**UNIT III SOCIAL IMPACT ASSESSMENT 8**

Urban Growth Indicators of Environmental Quality, Energy use, Fuel Economy in Transportation, Energy Efficiency strategies - Land Acquisition- Public Consultation - Cost benefit analysis - Rehabilitation Plans

**UNIT IV ENVIRONMENTAL MANAGEMENT PLAN 9**

Assessment of impacts – air – water – soil – noise – biological-visual — Cumulative Impact Assessment - Analysis of alternatives - Mitigation measures for Air and Noise Pollution – mitigating the impacts on flora and fauna - Environmental monitoring plan – Institutional arrangements- Documentation of EIA findings - Post project audit

**UNIT V CASE STUDIES 8**

Case studies on Environmental and social Impact assessment of Transportation projects such as Highways, Railways, Airports, Flyovers, Bridges, Ports and Harbor,

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Students would have understood the impact of Transportation projects on the environment and are able to develop and implement mitigation measures.
- They will also know about the legal requirements of Environmental Assessment for projects.

**REFERENCES:**


1. Larry W Canter, "Environmental Impact Assessment", McGraw Hill Publishers, 1996.
2. John Glasson, Riki Therivel, Andrew Chadwick, Introduction to Environmental Impact Assessment", 4th Edition, Routledge, New York.2012
3. David Banister; "Transport Policy and Environment" Routledge,UK,, 2002
4. World Bank; "the Impact of Environmental Assessment – A Review of World Bank Experience, Washington, 1997.
5. World Bank; Road and the Environment, World Bank Technical paper no. 363, Washington, 1997.
6. Scottish Natural Heritage, A handbook on environmental impact assessment, 4th Edition, Natural Heritage Management, www.snh.gov.uk., 2013


**TE7005 GEOSPATIAL TECHNIQUES L T P C**
**3 0 0 3**

**OBJECTIVE:**

- Introduce the students, the recent techniques of Remote Sensing and GIS and I Its application in Traffic and Transportation Engineering

**UNIT I INTRODUCTION TO REMOTE SENSING 10**

Definition – Components of Remote Sensing – Energy, Sensor, Interacting Body – Active and Passive Remote Sensing – Platforms – Aerial and Space Platforms – Balloons, Helicopters, Aircraft and Satellites – Electromagnetic Radiation – EMR Spectrum

**UNIT II INTRODUCTION TO GIS 10**

Basic Concept and Components – Hardware, Software – Data Spatial and non-spatial – Geo-referencing – Map Projection – Types of Projection – Simple Analysis – Data retrieval and querying

**UNIT III DATA STRUCTURES AND ANALYSIS 9**

Database – Raster and Vector data structures – Data storage – Run length, Chain and Block coding – Vector data storage – Topology – GIS Modelling - Raster and Vector data analysis – Buffering and overlaying techniques – Network Analysis – Spatial Analysis

**UNIT IV BASIC APPLICATIONS IN TRANSPORTATION 8**

Highway and Railway Alignment, location of transport terminals and roadside facilities, bus stops – Route optimization – Bus route rationalization – Accident analysis – Applications of Aerial Photography and Satellite Imageries

**UNIT V ADVANCED APPLICATIONS 8**

GIS as an integration technology – Integration of GIS,GPS and Remote Sensing Techniques – Advanced Traveler Information System (ATIS) – Automatic Vehicle Location System (AVLS)

**TOTAL: 45 PERIODS**

**OUTCOME:**

- The students would have knowledge on the basics of Remote Sensing and GIS techniques and their application in the Transport sectors.

**REFERENCES:**


1. Anji Reddy, "Remote Sensing and Image Interpretation", John Wiley and Sons Inc. New York, 1987.
2. Srinivas M.G, "Remote Sensing Applications", Narosa Publishing House, 2001.
3. Burrough P.A, "Principles of GIS for Land Resources Assessment", Oxford Publication, 1994.
4. Jeffrey Star and John Ester, Geographical Information System – An Introduction, Prentice Hall Inc., Englewood Cliffe, 1990.
5. Marble, D.F, Calkins, H.W and Penquest, Basic Readings in GIS, Speed System Ltd., New York, 1984.


**TE7006 INTELLIGENT TRANSPORTATION SYSTEMS L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To learn the fundamentals of ITS.
- To study the ITS functional areas
- To have an overview of ITS implementation in developing countries

**UNIT I INTRODUCTION TO INTELLIGENT TRANSPORT SYSTEM 8**

Introduction to Intelligent Transportation Systems (ITS) -Definition – Role and Responsibilities – Advanced Traveller Information System – Fleet Oriented ITS Services – Electronic Toll Collection – Critical issues – Security – Safety

**UNIT II ITS ARCHITECTURE AND HARDWARE 9**

Architecture – ITS Architecture Framework – Hardware Sensors – Vehicle Detection – Techniques – Dynamic Message Sign – GPRS – GPS – Toll Collection

**UNIT III ADVANCED TRANSPORT MANAGEMENT SYSTEM 10**

Video Detection – Virtual Loop - Cameras - ANPR – IR Lighting – Integrated Traffic Management – Control Centre – Junction Management Strategies- ATMS – Advanced Traveler Information Systems (ATIS)- Route Guidance – Issues -– Historical – Current – Predictive Guidance – Data Collection – Analysis – Dynamic Traffic Assignment (DTA) – Components – Algorithm.

**UNIT IV ADVANCED TRAVELLER AND INFORMATION SYSTEM 9**

Travel Information – Pre Trip and Enroute Methods- Basic ATIS Concepts – Smart Route System – Data Collection – Process – Dissemination to Travelers – Evaluation of Information – Value of Information – Business Opportunities

**UNIT V CASE STUDIES 9**

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.

**TOTAL: 45 PERIODS**

**OUTCOME:**

On completion of the course the students should be able to

- Understand the sensor and communication technologies.
- Apply the various ITS methodologies
- Define the significance of ITS under Indian conditions

**REFERENCES:**


1. Intelligent Transport Systems, Intelligent Transportation Primer, Washington, US, 2001.
2. Henry F.Korth, and Abraham Siberschatz, Data Base System Concepts, McGraw Hill, 1992.
3. Turban E.,"Decision Support and Export Systems Management Support Systems", Maxwell Macmillan, 1998.
4. Sitausu S. Mittra, "Decision Support Systems – Tools and Techniques", John Wiley, New York, 1986.
5. Cycle W.Halsapple and Andrew B.Winston, "Decision Support Systems – Theory and Application", Springer Verlog, New York, 1987
6. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.


**TE7007 LOGISTICS IN TRANSPORTATION ENGINEERING L T P C**

**3 0 0 3**

**OBJECTIVE:**

- Provides an understanding on Freight Transport, Modeling, Location of the Facility and its Management

**UNITI LOGISTICS 7**

Introduction – Trade Logistics Service, Freight Costs – Freight Demand Models.

**UNITII FREIGHT TRANSPORT 10**

Econometric Models for Freight Forecasting – Input Output Models – Regional Network Systems – Graph Theory Application in Network Planning.

**UNIT III DISTRIBUTION MANAGEMENT 10**

Supply Chain – Warehousing – Facility Location, Inventory – Mode Choice – Distribution System, Vehicle Routing and Scheduling- Monitoring of overloaded commercial vehicles

**UNIT IV LOGISTICS MANAGEMENT 10**

Logistics out sourcing – IT Application in Freight Logistics – Technology in Logistics Management – Intermodal Transportation

**UNIT V ITS APPLICATION IN FREIGHT TRANSPORT 8**

Commercial Fleet Management, Toll Plaza Analysis- E commerce -E tailing- City logistics Evaluating Schemes – case studies

**TOTAL : 45 PERIODS**

**OUTCOME:**

- Students will have a knowledge on the principles and practice of Freight Transport Modeling and provision of the Facilities

**REFERENCES**


1. Blanchard S.Benjamen, "Logistics Engineering and Management", Prentice Hall, Inc, Eaglewood Cliffs, New Jersey 07632, 1986
2. Coyle J.J.Bardi JE, "The Management of Business Logistics", West Publishing Company, New York, 1984
3. Daganzo F.C and Newell FG, Vol.19B, No.5, pp.397-407, Physical Distribution from a Warehouse; Vehicle Coverage and Inventory Levels, Transportation Research, 1985
4. Edwin Bacht J.A., "Geography of Transportation and Business Logistics", Wm C Brown Company Publishers, Dubuque, IOWA, 1970
5. Herron P.David, "Managing Physical Distribution for Profit", Harvard Business Review, 1979
6. Khanna K.K., "Physical Distribution Management", Logistical Approach, Himalaya Publishing House, Bombay, 1985
7. Planning Commission, Government of India, Total Transport System Study – Report on Commodity Flows, Railways, Highways and Coastal Shipping, (Interim) by RITES, New Delhi, 1987.
8. Shapiro D. Roy and Heskett L.James, "Logistics Strategy-Cases and Concepts", Wesg Publishing Company, New York, 1985


**TE7008 PAVEMENT MANAGEMENT SYSTEM L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To introduce the concepts of design, evaluation and performance of existing and new flexible and rigid pavements with due emphasis on systems approach and performance prediction models.

**UNIT I PAVEMENT MANAGEMENT PROCESS 9**

Historical background – general nature and applicability of systems methodology – basic components of Pavement Management System –Network and Project level of PMS - PMS functions- planning pavement investments.

**UNIT II EVALUATION AND PERFORMANCE 9**

General concepts – economic and functional evaluation – evaluation of pavement performance – evaluation of structural capacity – pavement distresses – condition surveys – safety evaluation-LCMS laser crack management system- application of GIS in pavement evaluation-case study.

**UNIT III PAVEMENT STRUCTURE & ITS EVALUATION 9**

Factors affecting Structural Condition of Flexible and Rigid Pavements- Effects of Subgrade Soil, Moisture, Pavement Layers, Temperature, Environment and Traffic on Structural Stability, Pavement Deterioration- Evaluation by Non-Destructive Tests such as FWD, Benkelman Beam Rebound Deflection, Plate Load Test, Wave Propagation and other methods of Load Tests- Evaluation by Destructive Test Methods, and Specimen Testing

**UNIT IV PERFORMANCE PREDICTION MODELS 9**

Pavement performance prediction - concepts, Techniques for developing prediction models – structural conditional deterioration models, mechanistic & empirical models, functional condition deterioration models, unevenness deterioration models and other models, ranking and optimization methodologies- AASHO, CRRI and HDM models – computer applications – Identification of alternatives –deterioration modeling- priority programming Methods.

**UNIT V REHABILITATION 9**

Repair of pavement defects – maintenance of flexible and rigid pavements system analysis - Pavement Overlays, Design of Flexible Overlay over Flexible Pavement by Benkelman Beam Deflection and other Methods, Flexible Overlays and Rigid Overlays over Rigid Pavements, Use of Geo synthetics in Pavement Overlays.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- The students would have knowledge on the concepts of design, evaluation and performance of flexible and rigid pavements

**REFERENCES:**


1. Ralph Haas, W. Ronald Hudson and John Zaniewski, Modern Pavement Management, Kreigar Publishing Company, New York, 1994
2. Stalin M.Y., Chapman and Hall Pavement Management for Airports, Roads and Parking Lots , New York, 1992.
3. Michael Sargious, Pavements and Surfacings for Highways and Airports, Applied Science Publishers Limited, London, 1975


**TE7009 RAIL TRANSPORTATION SYSTEMS – PLANNING AND DESIGN L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To expose the various aspects of planning and design of Rail Transportation Systems.

**UNIT I INTRODUCTION 9**

Railway Industry – Privatization – Financing – Competition with Road Transport

**UNIT II DEPENDABILITY ASPECTS 9**

Regularity, Reliability, Punctuality and Safety – Modern tools to improve dependability – Time Table – Development – Scheduling - Restoring

**UNIT III MANAGEMENT OF RAILWAY OPERATIONS 9**

Demand based Railway Planning – Freight and Passenger Train Services – Asset Maintenance and Management

**UNIT IV URBAN RAIL TRANSIT PLANNING 9**

Transit and Rail Tunnels- MRTS – LRTS, Metro Rail – Monorail – High speed trains- cable railway system for steep gradients- Tubular Rail-Tramways- Case Studies

**UNIT V RAILWAY INFRASTRUCTURE 9**

Modern Transit Facilities - Railway Track – Transfer Station – Structures – Bridges – Tunnels – Planning and Design aspects

**TOTAL: 45 PERIODS**

**OUTCOME:**

- The students would have gained knowledge on Rail Infrastructure Planning, Operation and Management.

**REFERENCES:**


1. Brain Richards, Transport in Cities
2. Roberty Cervero, The Transit Metropolis, Island Press, 1998
3. Vukan R.Vuchie, Urban Transit: Operations, Planning and Economics, John Wiley and Sons Inc., 2005
4. Vukan R.Vuchie, Urban Transit Systems and Technology, John Wiley and Sons, 2007


**TE7010 ROAD SAFETY SYSTEM L T P C**

**3 0 0 3**

**OBJECTIVES:**

- Helps in identifying the reasons for road accidents and scientific Investigation.
- Provides knowledge on road safety audit and its methodology

**UNIT I INTRODUCTION 9**

Causes of accidents – Human factors – Vehicles – Road and its condition – Environmental Studies- Case studies.

**UNITII ACCIDENT DATA COLLECTION 9**

Accident Data Collection- accident investigation and reduction; -- accident costs -accident prevention- Types of Statistics- Accident Rates - Statistical Displays and their Use- Identifying High-Accident Systems-Accident Statistics-Locations- Crash reconstruction--Computer Record Systems –RADMS- Case studies.

**UNIT III ACCIDENT ANALYSIS TECHNIQUES 9**

Collision Diagram – Preparation, Spatial Analysis of Accidents – Methods and GIS in Accident Analysis - Black Spot, Black Route and Area Identification. Accident Prediction Models – Development – Empirical Bayees Approach – Before and After Evaluation – Case Studies

**UNIT IV ROAD SAFETY AUDIT 9**

Introduction to safety- Road safety management system- Need for Road Safety Audit – Concept and Elements of Safety Audit – Safety Audit for existing roads – Legal requirements – Provisions of Motor Vehicle Act and role of NGO"s in prevention of accidents.

**UNIT V ACCIDENT STUDIES AND INVESTIGATION 9**

Accident data – Identification of Accident Prone Location – Prioritisation – Investigation Safety considerations on completed roads and in work zone- Mitigation measures.

**TOTAL : 45 PERIODS**

**OUTCOME:**

- The students would have gained knowledge on different aspects of road safety audit and its methodology

**REFERENCES:**


1. Evans, L., Traffic Safety, Science Serving Society, 2004.
2. Ogden, K. W., Safer Roads: A Guide to Road Safety Engineering. Avebury Technical, 1996.
3. Elvik, R., and Vaa, T., The Handbook of Road Safety Measures, Elsevier, 2004.
4. Institute of Transportation Engineers (ITE), The Traffic Safety Toolbox: A Primer on Traffic Safety, ITE.
5. Road Safety manuals by various organisations in India and other developed countries.
6. Ministry of Surface Transport, "Accident Investigation and Prevention Manual for Highway Engineers in India, Government of India, 2001.
7. Robert F.Baker, "The Highway Risk Problem – Policy Issues in Highway Safety", John Wiley and Sons.


**TE7011 SUSTAINABLE URBAN AND TRANSPORT DEVELOPMENT L T P C**
**3 0 0 3**

**OBJECTIVE:**

- Helps in understanding the basic concept of Sustainable Urban and Transport Development and its influence on region, city and built environment.

**UNIT I SUSTAINABLE URBAN AND TRANSPORT PRINCIPLES 8**

Urban Environmental Sustainability, Urban Development, Urban Sustainable Development, Methods and Tools for Sustainable Appraisal, Sustainable Transportation – Principles, indicators and its implications

**UNIT II URBAN PLANNING AND ENVIRONMENT 7**

Environment and Resources, Sustainability Assessment, Future Scenarios, Form of Urban Region, Managing the change, Integrated Planning, Sustainable Development

**UNIT III THE URBAN BUILT ENVIRONMENT 9**

Urban Form, Land Use, Compact Development, Principles of street design- complete streets, Transport Integrated Urban land use Planning, , Guidelines for Environmentally sound Transportation

**UNIT IV SUSTAINABLE TRANSPORTATION MODES PLANNING 11**

Pedestrian – Planning Principles, Tools, Designs, Methods to measure success, Cycles- Planning Principles, Cycle Track Network, Crossings and intersections and junctions, Transit Planning, Road Side Infrastructure Planning

**UNIT V TRAVEL AND TRANSPORT 10**

Transport and Environment – Equity Principle, Accessibility, Mobility – Roads, Traffic, Public Transport, Business and Goods Traffic, Relationship to land use, Financing and Pricing – Economic Benefits of Sustainable Transportation

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Students would have learnt the importance of sustainable urban and transport planning and its benefits to the human community.

**REFERENCES:**


1. Joe Ravetz, City Region 2020 – "Integrated Planning for a Sustainable Environment, 2000
2. George Godwin; "Traffic, "Transportation and Urban Planning"; Pitmen Press,Great Britain, 1981.
3. Sustainable Transportation and TDM – Planning the balances, Economic, Social and Ecological objectives; Victoria Transport Policy Institute, 2007 .
4. UNCHS, Habitat, Cities in a Globalizing world, Global report on Human Settlement, 2001.
5. Tumlin Jeffrey, "Sustainable Transportation Planning- Tools for Creating Vibrant", Healthy and Resilient Communities, John Wiley & Sons, 2012.
6. IUT toolkit.


**TE7012 TRANSPORTATION MODELING AND SIMULATION L T P C**
**3 0 0 3**

**OBJECTIVE:**

- Offers basic and fundamental principles of Systems Approach and its application in simulating and modeling the complex and dynamic traffic and transportations systems.

**UNIT I SYSTEMS APPROACH CONCEPT 9**

System – Concepts, Theories – Classification – Models – Concept of Modeling exercises - Phases in model building process – System Approach – System Dynamics (S.D) View Points – Physical Flow – Information Flow.

**UNIT II MODEL CONCEPTUALISATION 9**

Causal Loop (CL) Diagramming – Diagramming Approach – Justification for links – Conceptualisation and Development of Causal Loop Representations - Case Study examples in C.L diagramming in Transportation Planning – Principles of Systems and its Hierarchies.

**UNIT III MODEL DEVELOPMENT AND SCENARIO ANALYSIS 10**

System Dynamic Model Development - Flow Diagraming methodologies – Stocks and Rate Variable Concepts – Relevance of selection in Level and other auxiliary variables – Significance of Sensitivity Analysis in Simulation Modeling – Importance of Policy and Scenario Analysis.

**UNIT IV MODEL VERIFICATION AND VALIDATION 7**

Concepts of Model Verification – Model Calibration – Model Validation - Sensitivity and Dimensional Analysis – Methods of SD Model Validation – Comparison of Conventional Model Validation with Simulation Model Validation efforts.

**UNIT V MODELING TRANSPORTATION SYSTEMS 10**

Basics of simulation- Simulation Models and classification- Application to Traffic and Transportation Systems – Modeling of any traffic systems for service quality enhancement – Modeling of transport, energy and environment system interactions- Future traffic simulation Model.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Students would have the knowledge in system Dynamics simulation Modeling efforts.

**REFERENCES:**


1. Pratab Mohapatra K.J.et al., "Introduction to System Dynamics Modeling", University Press, Hyderabad,1994
2. Thirumurthy A.M., "Environmental Facilities and Urban Development in India – A System Dynamics Model for Developing Countries, Academic Foundations, India,1992.
3. Nancy Roberts et al., "Introduction to Computer Simulation – A System Dynamics Modeling Approach", Addison – Wesley, London,1983
4. Papacostas C.S., Prevedouros, "Transportation Engineering and Planning", 3rd Edition, Prentice Hall of India, New Delhi,2002
5. John D.Edwards, Jr. P.E, "Transportation Planning Handbook, Institute of Transportation Engineers, Prentice Hall Publication, Washington D.C., USA,1999


**TE7013 URBAN INFRASTRUCTURE AND ASSET MANAGEMENT L T P C**
**3 0 0 3**

**OBJECTIVE:**

- The course will emphasize the use of emerging technologies, information systems, and decision making tools that support the various elements of the asset management framework.

**UNIT I ROAD ASSET MANAGEMENT 9**

Road Asset management- designing and developing rigid (or flexible) pavement with integrated structure for underground utilities & services- Network of underground road system, need for and planning and development.

**UNIT II INNOVATIVE TRANSPORT MODES 9**

straddling bus concept and development (eg China)- e-rickshaws- Alternate (renewable) energy options for powering transport system- solar powered aircraft -bio-bus and its impact on solid waste management - solar-powered traffic signals and street lights- all-electric bus route with wireless charging -buses park over metal plates buried in the road.

**UNIT III TELECOMMUNICATION & ITS IMPACT ON TRANSPORT 9**

e-commerce- e-tailing-mobile application in trade &commerce- internet-banking- internet and mobile phone in governance-services ranging from e-billing & payment for services- EB/telephone/income tax/ municipal tax & service charges/cooking gas booking &payment-booking and payment of air, train &train tickets; booking and payment of cinema tickets- teleshopping of groceries-tele-checking at airports- obtaining birth and death certificates-booking and payment for call taxis & autorickshaws; carpooling thro' net and mobile phones-global meets through teleconferencing- case studies

**UNIT IV CLOUD-COMPUTING AND ITS IMPACT ON TRANSPORT 9**

The contribution of transport planning & development in conceptualization of smart cities-advances in capturing and processing traffic data in real time and managing traffic congestion- role of SCOOT & SCAT in reducing and minimizing traffic congestion- establishment of a sensor-networked and monitored city communication infrastructure, efficiently phasing traffic lights, and providing real-time guidance to drivers, can aid in reducing congestion. Digitally monitored parking spaces, able to dynamically alter prices according to available spaces, help control time spent cruising for parking.

**UNIT V ROLE OF SMART CARD AND COMMUTING 9**

Electronic Road Pricing (ERP) and congestion pricing- Innovative financing- carbon credit -case studies

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Students would have the knowledge of innovative transport modes, telecommunication and cloud-computing impacts on transportation.

**REFERENCES:**


1. International Infrastructure Management Manual. Edition 2011.
2. 'Asset Management for Road sector', OECD Publications Service, 2, Paris Cedex 16, France 2001.


**TE7014 WATERWAYS TRANSPORTATION SYSTEM – PLANNING AND DESIGN L T P C 3 0 0 3**

**OBJECTIVE:**

- To expose the various aspects of planning and design of Water Transportation Systems.

**UNIT I INTRODUCTION 9**

Fresh Water and Salt Water Navigation – Ocean, Currents and Tide – Canals and Waterways – Ports - Types of Ships

**UNIT II LOGISTICS AND MULTIMODAL TRANSPORT 9**

Containers – Distribution and Collection by Road and Rail – Vehicles and Equipment used – Trade Routes- liquid cargo

**UNIT III PORT PLANNING 9**

Traffic Forecast, Demand, Users, Capacity – Berth occupancy – Service time – Waiting time – Principles of Planning Port Layout – Handling characteristics – Voyage Estimating

**UNIT IV PORT AND TERMINAL MANAGEMENT 9**

Role of ports in trade and transport – Port facility for handling liner, dry bulk and liquid trade – Basics of Port Business – Customs – Immigration, Port Health – Marine Safety – Pricing – Traffic Management in Port Premises

**UNIT V INLAND WATER WAYS AND OTHER MODES OF TRANSPORT 9**

Inland Water Transport – Planning, limitations and advantages – Case Studies –Pipelines – Ropeways – Beltways – other means of transport – Characteristics and Applications

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Students would have gained knowledge on various aspects of planning and design of Water Transportation Systems.

**REFERENCES:**


1. Leslie A.Bryan, "Principles of Water Transportation", University of Chicago Press
2. Paul H.Wright, J.Ashford Norman, "Transportation Engineering, Planning and Design", John Wiley and Sons Inc., 1997
3. "Shipping and Inland Water Transport for Eleventh Five Year Plan" – Report by Planning Commission