

Pavement Design Analysis

Course Objective:

- To make students aware of design procedure of different types of pavements.
- To impart the knowledge of construction techniques of various category of roads.
- To give knowledge of failures in pavements and their preventive measures and evaluation techniques of pavements along with strengthening techniques.

Course Content

Branch	Subject Title	Subject Code	Credit allotted subject wise		
			L	T	P
M.E. (Transportations Engg)	Pavement Analysis & Design	MET-2221	3	-	-

UNIT I:

Types of pavements – Factors affecting design of pavements – wheel loads –ESWL
Concept- tire pressure – contact pressure, Material characteristics – Environmental and other factors.

UNIT II:

Stresses in pavement – Stresses in flexible pavement layered systems concept – one layer system – Boussinesq Two-layer system – Burmister Theory for Pavement Design.
Stresses in rigid pavements – relative stiffness of slab, modulus of sub-grade reaction – stresses due to warping, stresses due to loads, stresses due to friction.

UNIT III:

Pavement design: CBR Method of Flexible Pavement Design- IRC method of flexible pavement design. - AASHO Method of Flexible Pavement design, Design Mix-Marshall's Method of Bituminous Mix design. IRC method of Rigid pavement design – Importance of Joints in Rigid Pavements- Types of Joints – Use of Tie Bars and Dowell Bars.

UNIT IV:

Highway construction – Construction of Earth Roads- Gravel Roads – WBM Roads- Bituminous Pavements- Cement Concrete Roads- Steps in Construction- Reinforced Concrete Pavements – Soil Stabilization – Methods and Objectives- Soil-cement Stabilization and Soil-lime Stabilization.

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UNIT V:

Need for Highway Maintenance- Pavement Failures- Failures in Flexible Pavements- Types and Causes-Rigid Pavement Failures- Types and causes- Pavement Evaluation- Benkleman Beam method- Strengthening of Existing Pavements- Overlays.

Course Outcomes: -

After completion of the course, the students will be able to

CO1: Understand the various factors affecting the pavement design

CO2: Pavement stress and strain distribution theory, modeling, and calculation methods

CO3: Analyze and design the pavements using IRC recommendations.

CO4: Impart the knowledge of construction techniques of various category of roads and ailures in pavements and their preventive measures

Text Books:

1. Highway engineering by Khanna & justo
2. Yoder and Witczak, Priniciples of Pavement Design, John Wiley and Sons
3. Yang. H. Huang, Pavement Analysis and Design, Second Edition, Prentice Hall Inc.
4. IRC:37 & 58 Codes for Flexible and Rigid Pavements Design.

References:

1. Rajib B. Mallick and Tahar El-Korchi, Pavement Engineering – Principles and Practice, CRC Press (Taylor and Francis Group)
2. W.Ronald Hudson, Ralph Haas and Zeniswki , Modern Pavement Management, McGraw Hill and Co .
3. Shell Pavement Design Manual – asphalt pavements and overlays for road traffic, by Nilanjan Sarkar, OomsAvenhorn Holding India Pvt.Ltd;

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Traffic Engineering

Course Objectives

- Student will learn principles, concept, methodology, codal provisions, necessity and scope of traffic characteristics Field studies,
- Student will learn analysis computation, forecasting as per codal provisions, of various field studies. Related to traffic engg.
- Student will learn to design parking, and accident preventive measures system
- Student will learn to work as a team member and leader in conducting various field studies.

Course Content

Branch	Subject Title	Subject Code	Credit allotted subject wise		
			L	T	P
M.E. (Transportation Engg)	Traffic Engineering	MET-2222	3	-	-

Unit – I

Introduction Definitions and normal scope of study within traffic engineering.

Traffic Characteristics:

- Road User Characteristics:** General Human characteristics, Physical Characteristics-Mental and Emotional factors, reactions to traffic situations, factor affecting reaction time, PIEV-theory.
- Vehicular characteristics:** Vehicular characteristics affecting road design width, height, Length, and other dimensions, Weight, Power, Speed and braking capacity. IRC and international standards for maximum vehicular dimensions and weight, Resistances to tracking and power requirements.

Unit – II

Speed Studies:

- i) Spot speed studies-data analysis and interpretations
- ii) Speed and delay studies-Purpose, causes of delay, various methods of speed and delay studies.

Unit – III

Traffic volume studies

- i) Traffic volume studies and characteristic
- ii) Origin and destination studies: Various methods of O and D studies and sampling.

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Unit – IV

Traffic capacity studies-

Volume and density relationships, critical density, basic, possible and practical capacities. Factors affecting possible and practical capacities.

Unit – V Accidents and Parking studies

Parking studies and characteristics-Public interest in parking studies, cordon count, space inventory, parking practices. Evaluation of parking controls.

Accident studies and characteristics-Causes of accidents, accident studies and records, reports application of accident studies, preventive measures.

Course Outcome

- CO1: Student will be able to illustrate, compare, list principles, concept, elements, methodology, codal provisions, necessity and scope of traffic characteristics
Field studies
- CO2: Student will be able to analyse a traffic related problem and will suggest appropriate survey method to collect data.
- CO:3 Student will be able to design parking space and accident preventive measures.
- CO:4 Student will be able work as an individual and team leader.

Reference Books

1. Transportation Engineering Arora, N. L. Khanna Publishers, Delhi, 1996, ISBN: 81-7319-0933,
2. Traffic Engineering and Transport Planning Kadiyali, L.R. Khanna Publishers, Delhi, 2001, ISBN: 10: 8185240779;
3. Transportation Engineering Vol. I & II Vazirani, V N Chaondola, S P Khanna Publishers. Delhi, 2016 ISBN: 9780128038185; 9780128038895
4. Traffic planning and design Saxena, S C Dhanpat Rai & Sons Delhi, 2016 ISBN-10: 815550
5. Indian Highways- IRC Journal Journal-monthly issue IRC (Indian road Congress)! India, 1973, ISSN: 0376-7256



Highway Construction

Course Objectives: -

- To impart knowledge about pavement construction and maintenance
- To introduce the fundamental concepts of highway construction
- To enable the students to understand the importance of right construction methodology

Course Content

Branch	Subject Title	Subject Code	Credit allotted subject wise		
			L	T	P
M.E. (Transportation Engg)	Highway Construction	MET-2223	3	-	-

Unit – I

Classification of types of highway construction, Suitability of each type under Indian conditions. Selection of base course and surface course.

Earthwork and Soling: Selection of soils, construction of embankments, excavation and compaction equipments. Field and laboratory tests for quality control. Stone soling, brick soling, current practices.

Construction of earth roads, gravel roads, soil stabilized roads, water bound macadam. Paved roads (i) bricks (ii) stones.

Unit – II

Bituminous Construction : Properties requirements and specifications of materials, equipments and plants. Detailed construction procedure of each type. Field and laboratory tests for quality control. Choice of binders under different conditions. IRC, British, and MOST Specifications.

Recommendations under Indian Conditions: Bituminous surface treatments, interface treatments-prime coat, and tack coat, surface dressing and seal coat, grouted or penetration macadam, bituminous bound macadam, Sheet asphalt, bituminous concrete, mastic asphalt, dense tar surfacing.

Unit – III

Cement Concrete Road Construction: Necessity of providing a base course under cement concrete road construction. Selection of materials, Constructions methods, detailed construction procedure. Quality control tests (Lab. and Field). Construction equipment's.



Joints in Cement Concrete Pavements: Classification of various types of joints, necessity of providing each type, method of construction of joints, load transfer devices, dowel bars, tie bars. Joint filler and sealer materials, IRC specifications.

Unit – IV

Reinforced Cement Concrete Road Construction: Necessity of providing reinforcement in cement concrete pavements, continuously reinforced concrete pavements, prestressed concrete pavements and fibre reinforced concrete pavements. Selection of the mix, compaction method and construction procedure for each type. Recommendations under Indian conditions.

Unit – V

Construction Planning and Management: CPM/PERT in Highway Construction.

Course Outcomes: -

After completion of the course, the students will be able to

CO1: Understand the concept of Earth work and Soiling.

CO2: Know about the factors that affect Bituminous Construction and Cement Concrete Road Construction

CO3: Understand the concept of construction planning and management.

References Books: -

1. Bituminous road construction in India by Prithvi Singh Kandhal, PHI Learning Pvt. Ltd.
2. Highway Engineering by S. K. Khanna, C.E.G Justo, em Chand and Bros, Roorkee.
3. Highway Construction and Maintenance by Avinash Gupta, Random Publications.

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ELECTIVE –II (A)

DESIGN AND MAINTENANCE OF RURAL ROADS

Course Objectives:

- To make students aware of importance of rural road and its planning.
- To impart the knowledge of design and construction techniques rural roads.
- To give knowledge of various alternative and waste material used in rural road construction.

Course Content

Branch	Subject Title	Subject Code	Credit allotted subject wise		
			L	T	P
M.E. (Transportation Engg)	DESIGN AND MAINTENANCE OF RURAL ROADS	MET- 2224(A)	3	-	-

UNIT –I

Introduction: Importance of Rural roads, Classification of rural roads, Terrain classification, Socio-economic impact of rural roads. Planning and Alignment: Data base for master plan, Concept of network planning, Rural Roads plan, Road alignment, Governing factors for route selection,

UNIT-II

Geometric Design: Introduction, Design speed, Basic principles of geometric design, Factors controlling alignment, Special considerations while aligning hill roads, Surveys, Detailed project report, Environmental issues, Elements, Horizontal and vertical alignment, Alignment compatibility, Lateral and vertical clearances.

UNIT-III

Road Materials: General, Soil and material surveys, Soil as road construction material, Stabilized soils, Aggregates for pavement courses, new materials and stabilizers, Materials for bituminous construction, Materials for semi-rigid and rigid pavement, Materials for special pavements Climatic suitability of concrete materials

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UNIT -IV

Pavement Design: Introduction, Design parameters, Pavement components, Design of flexible pavement, Design of semi-rigid pavement, Design of rigid pavement, Design of special pavements, Drainage and Shoulders, Earthwork, Sub-base, Base course, Bituminous constructions, Semi-rigid pavement construction, Concrete pavements, Construction of special pavements, Equipment required for different operations

UNIT-V:

Road Concept and use of Waste Materials: Introduction, Significance of green roads, fly ash for road construction, Iron & steel and copper slags, Lime-rice husk ash concrete, Recycled concrete aggregate, other waste materials. Distresses/defects in pavements, Definitions Green of maintenance activities, Inventory of road and inspection, maintenance of rural roads.

Course Outcomes:

At the end of the course, the students will be able to:

- CO1: Understand the concepts and element of geometric design of rural road
- CO2: Gain knowledge about the material and its characterization used to construct rural roads.
- CO3: Analyze and design the pavements using IRC recommendations.
- CO4: Gain knowledge about the use of Waste material in rural road.

Text Books.

Highway Engineering, S.K. Khanna and C.E.G Justo and A. Veeraragavan, Nemchand Brothers publications.

Reference Books

1. IRC: SP 20-2002 „Rural Roads Manual“
2. IRC: SP 72-2015 „Guidelines for the Design of Flexible Pavements for Low
3. Volume Rural Roads“
4. IRC: SP 62-2014 „Guidelines for the Design and Construction of Cement Concrete Pavements for Rural Roads“
5. IRC „Specifications for Rural Roads“, MoRD,
6. CRRRI „Various Reports on Use of Waste Materials

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ELECTIVE -II (B)

Traffic Management and Design

Course Objective:

- To have an overall knowledge of the traffic components and assess the traffic characteristics and related problems
- To develop a strong knowledge base of traffic planning and its management in any transportation area
- To provide knowledge of traffic control devices and its techniques in transportation interaction

Course Content

Branch	Subject Title	Subject Code	Credit allotted subject wise		
			L	T	P
M.E. (Transportation Engg)	Traffic Management and Design	MET-2224(B)	3	-	-

Unit - I

Principles and methodology of Traffic Management. Traffic Systems Management-an overview. Various techniques of management, Regulatory management systems, Cybernetics, applications to traffic management systems. Directional flow management, unbalanced flow, exclusive bus lanes.

Unit - II

Speed Control and Zoning, Parking Control-midblock and intersection area management. Traffic Segregation and channelization. Principles and design of Traffic Signs, their placement, visibility, sign information, letter size design, symbolic sign design, universal signs. Pavement markings, design details, delineation of pavement markings, delineators for road bridges, markings in overall management.

Unit - III

Signalization : Design-cycle, phase, turn-control signal, pedestrian signal-various criteria and design considerations. Signal indications and their appropriateness, coordination of signals. Signal preemption for priority movement-principles and design. Filter signals.

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Unit – IV

Traffic system management-route and network management. Area traffic management. City wide traffic control and management, centralized data processing and monitoring system.

Unit – V

Evaluation of traffic design for management. Before and after study technique, evaluation procedure and methodology, system performance evaluation

Course Outcomes:

At the end of the course, the students will be able to:

CO1: gain knowledge in the fundamental's components of traffic engineering and its features.

CO2: Get a vast understanding on various traffic enforcements rules and regulations.

CO3: Evaluate the traffic design for management

References Books –

1. L.R. Kadiyali, *Traffic Engineering and Transport Planning*.
2. Williamsen and Ortuzar, *Modelling Transport*.
3. Kanafani, *Transp. Demand Analysis*.
4. C. J. Khisty and B. K. Lall, *Transportation Engineering: An Introduction*, Prentice-Hall India, 2003. Hutchinson, B.G., *Principles of Urban Transport Systems Planning*, Scripta, McGraw-Hill, NewYork, 1974.
5. Khisty C.J., *Transportation Engineering - An Introduction*, Prentice Hall, NJ, 2007.
6. Papacostas C.S. and Prevedouros, P.D., *Transportation Engineering & Planning*, PHI, New Delhi, 2002.

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ELECTIVE -II (C)

Transportation Economics, Project Evaluation and Appraisal

Course Objectives:

- Learn the importance of highway economics, measurements of benefits due to improvements, Present concepts of operations.
- Learn the application of methods of economic evaluation to road way projects.
- Introduce the economic concepts of supply, demand, pricing and market structures

Course Content

Branch	Subject Title	Subject Code	Credit allotted subject wise		
			L	T	P
M.E. (Transportation Engg)	Transportation Economics, Project Evaluation and Appraisal	MET-2224(C)	3	-	-

Unit - I

Principles: Purpose and major considerations in Transport Economic analysis. Identification and measurement of transportation costs and benefits.

Unit - II

Cost and benefits. Capital cost, inflation cost, interest during construction, maintenance cost, road user costs, vehicle operating cost, accident cost, congestion cost and pricing, non-user cost and consequences. Savings and benefits, road-user benefits and consumer surplus. Social costs and benefits from transportation project options. Interest and vest charge, concept of interest and vest charge, rate of vest charge, compound interest equations.

Unit - III

Methods of economic analysis, characteristics and basic understanding of the methods. Comparisons and limitations of various methods, ranking of independent alternative projects.

Unit - IV

Techno-economic feasibility studies and evaluation of alternative projects. Welfare economics, evaluation and appraisal of transport investments.

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Unit – V

Special considerations for transportation economics in analysis for developing countries. Appraisal and evaluation of economic consequences of an urban bypass.

Course Outcomes:

At the end of the course, the students will be able to:

CO1: to apply the concepts and tools of microeconomics.

CO2: to understand basic concepts of economic analysis.

CO3: to understand depreciation and its application.

CO4: to appreciate the basic application of economics.

References Books –

1. L.R. Kadiyali, *Traffic Engineering and Transport Planning*.
2. Williamsen and Ortuzar, *Modelling Transport*.
3. Kanafani, *Transp. Demand Analysis*.
4. C. J. Khisty and B. K. Lall, *Transportation Engineering: An Introduction*, Prentice-Hall India, 2003. Hutchinson, B.G., *Principles of Urban Transport Systems Planning*, Scripta, McGraw-Hill, New York, 1974.
5. Khisty C.J., *Transportation Engineering - An Introduction*, Prentice Hall, NJ, 2007.
6. Papacostas C.S. and Prevedouros, P.D., *Transportation Engineering & Planning*, PHI, New Delhi, 2002.

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Open Elective (A)

ENVIRONMENTAL IMPACT ASSESSMENT OF TRANSPORTATION PROJECTS

Course Objectives:

- Explain the concepts of environmental impact assessment and apply in the projects
- List and define various indicators such as terrestrial subsystems, Indicators aquatic sub systems, Socio-economic and able to Select various indicators for EIA studies.
- Explain the impacts of transportation related components on environment
- Explain and illustrate the methodologies for environmental impact assessment

Course Content

Branch	Subject Title	Subject Code	Credit allotted subject wise		
			L	T	P
M.E. (Transportation Engg)	Environmental Impact Assessments of Transportation Projects	MET-2225(A)	3	-	-

UNIT 1:

Introduction: Environment and its interaction with human activities - Environmental imbalances - Attributes, Impacts, Indicators and Measurements - Concept of Environmental Impact Assessment (EIA), Environmental Impact Statement, Objectives of EIA, Advantages and Limitations of EIA

UNIT 2:

Environmental Indicators - Indicators for climate - Indicators for terrestrial subsystems - Indicators for aquatic subsystems - Selection of indicators - Socio-economic indicators - Basic information - Indicators for economy - Social indicators - Indicators for health and nutrition - Cultural indicators - Selection of indicators.

UNIT 3:

Environmental Impact Assessment for Transportation Projects: Basic Concepts, Objectives, Transportation Related Environmental Impacts – Vehicular Impacts – Safety & Capacity Impacts – Roadway Impacts – Construction Impacts, Environmental Impact Assessment – Environmental Impact Statement, Environment Audit, Typical case studies

UNIT 4:

Environmental Issues in Industrial Development: On-site and Off-site impacts during various stages of industrial development, long term climatic changes, Greenhouse effect, Industrial effluents and their impact on natural cycle, Environmental impact of Highways, Mining and Energy development

UNIT 5:

Methodologies for Carrying Environmental Impact Assessment: Overview of Methodologies, Adhoc Checklist, Matrix, Network, Overlays, Benefit Cost Analysis, Choosing a Methodology, Review Criteria.

Course Outcomes:

At the end of the course, the student will be able to:

- CO1: To describe the environmental imbalances, indicators and explain the concept of EIA
- CO2: To identify and describe elements to be affected by the proposed developments and/or likely to cause adverse impacts to the proposed project, including natural and man-made environment;
- CO3: To identify the negative impacts and propose the provision of infrastructure or mitigation measures

REFERENCE BOOKS:

1. Jain, R.K., Urban, L.V., Stracy, G.S., (1991), "Environmental Impact Analysis", Van Nostrand Reinhold Co., New York
2. Rau, J.G. and Wooten, D.C., (1996), "Environmental Impact Assessment", McGraw Hill Pub. Co., New York
3. Canter, L.W., (1997), "Environmental Impact Assessment", McGraw Hill Pub. Co., New York
4. Grand Jean, E. Gilgen A., "Environmental Factors in Urban Planning", Taylor and Francis Limited, London, 1976.
5. UNESCO, (1987), "Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development", UNESCO/UNEP, Paris

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Open Elective (B) PAVEMENT MANAGEMENT SYSTEM

Course Objectives:

- Discuss the need of PMS in planning and maintaining the flexible pavements.
- understand the performance of pavements, causes of failure, rating methods.
- Formulate the development and application of models for pavement management.
- Understand the need of application of methods of prioritization and application of innovative methods.

Course Content

Branch	Subject Title	Subject Code	Credit allotted subject wise		
			L	T	P
M.E. (Transportation Engg)	Pavement Management System	MET-2225(B)	3	-	-

UNIT 1:

Introduction: Definition -Components of Pavement Management Systems, Essential features. Pavement Management Levels and functions: Ideal PMS- Network and Project levels of PMS-Influence Levels- PMS Functions- Function of Pavement evaluation.

UNIT 2:

Pavement Performance: Serviceability Concept- Development of Serviceability Index- PSI-RCI- Roughness- Roughness Components- Evaluation-Equipment- Universal Roughness Standard-Techniques-IRI – Application of Roughness Data in Network level and Project Level. Evaluation of Pavement Structural capacity: - Basics- NDT and Analysis—Condition Surveys-Distress-Destructive Structural Analysis- Application in Network and Project Levels-Methods and Equipment- Combined Measures of Pavement Quality-Concept-Methods of developing a combined index-limitations.

UNIT 3:

Evaluation of Pavement Distress and Functional Aspects – Principles- Condition Survey-Survey Methodology-Types of Distress-Examples-Equipment-Indexes-Applications of Distress data- Pavement Safety-Components –Evaluation-Basic Concepts of Skid resistance-Methods of measuring skid resistance- Effect of Time, Traffic and Climate on Skid resistance. Establishing Criteria – Need- Characteristics-effect of changing criteria- examples-Prediction models for pavement deterioration-

Need-measures to be predicted-requirements-Basic types of Prediction Models- HDM and other deterioration models. Rehabilitation and Maintenance: Identification of Alternatives-Deterioration Modeling- Priority Programming Methods.

UNIT 4:

Expert Systems and Pavement Management: Role of computers in pavement management, applications of expert systems for managing pavements, expert system for pavement evaluation and rehabilitation, knowledge-based expert systems, case studies.

UNIT 5:

Implementation of Pavement Management Systems. - Introduction-major steps-Maintenance Management.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Identify the factors influencing performance of pavements

CO2: Carry out structural and functional evaluation of pavements

CO3: Explain the use of models for pavement management

CO4: Develop a framework for efficient pavement management system

REFERENCES:

1.Ralph Haas and Ronald W. Hudson, 'Pavement Management System', McGraw Hill Book Co. 1978.

2.Ralph Haas, Ronald Hudson Zanieswki. 'Modern Pavement Management, Kreiger Publications, New York,

3.Proceedings of North American Conference on Managing Pavement, USA, .

4.Proceedings of International Conference on Structural Design of Asphalt Pavements NCHRP, TRR and TRB Special Reports, USA,



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Open Elective (C) Highway Bridges

Course Content

Branch	Subject Title	Subject Code	Credit allotted subject wise		
			L	T	P
M.E. (Transportation Engg)	Highway Bridges	MET-2225(C)			
			3	-	-

Unit – I

Bridge site investigation and survey: Site selection, design data collection, different surveys.

Unit – II

Bridge hydrology: Scour, depth of foundation, economic span, afflux.

Unit – III

Loading Standards: Design loads and forces, Indian loading standards of highway bridges, design of R.C.C. beam and slab bridges.

Unit – IV

Bridge Components: Type of foundations, bridge super structure and sub structure, erection of bridges.

Unit – V

Testing and strengthening of bridges: Inspection and data collection, bridge failure, fatigue of bridges, S-N curve, strengthening of bridges.

Reference Books: -

1. Swami Saran, "Analysis and Design of Substructures", Oxford & IBH Publishing Co., 1996. 2. J.E. Long, "Bearings in Structural Engineering", Newnes Butterworth & Co., 1974.
2. R.E. Rowe, "Concrete Bridge Design", 1 st Edition, Elsevier Science and Technology, 1962. 4. L.G. Hendry and A.W. Jaeger, "The Analysis of Grid Frameworks and Related Structures", Chatto & Windus, 1958.
3. Jaeger & Bakht, "Bridge Analysis by Microcomputer", Mc Graw Hill, 1989.

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