**Scheme and Syllabus**

# POSTGRADUATE DEGREE COURSE

## M.Tech.

## Transportation Engineering

# RAJASTHAN TECHNICAL UNIVERSITY, KOTA

**With Effective from Session 2020-21**

## Teaching and Examination Scheme
## M. Tech.: Transportation Engineering
## I Semester

| SN | Category | Course | | Contact hrs./ week | | | Marks | | | | Cr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Code | Title | L | T | P | Exam Hrs. | IA | ETE | Total | |
| 1 | PCC | 1MTR1-01 | Transportation Planning | 3 | | - | 3 | 30 | 70 | **100** | **3** |
| 2 | PCC | 1MTR1-02 | Advanced Highway Material Characterization | 3 | | - | 3 | 30 | 70 | **100** | **3** |
| 3 | PEC | 1MTR2-11 | Railway, Airports, Ports and Harbours | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 4 | | 1MTR2-12 | Statistical Methods in Transportation Engineering | | | | | | | | |
| 5 | | 1MTR2-13 | Road transport management and economics | | | | | | | | |
| 6 | PEC | 1MTR2-14 | Management of quality and safety in highway construction | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 7 | | 1MTR2-15 | Tunnel engineering | | | | | | | | |
| 8 | | 1MTR2-16 | Geometric Design | | | | | | | | |
| 9 | MCC | 1MCC3-21 | Research Methodology & IPR | 2 | - | - | 2 | 30 | 70 | **100** | **2** |
| 10 | PCC | 1MTR1-06 | Highway Material Testing Laboratory | - | - | 4 | - | 60 | 40 | **100** | **2** |
| 11 | PCC | 1MTR1-07 | Pavement Design Laboratory | - | - | 4 | - | 60 | 40 | **100** | **2** |
| 12 | SODECA | 1MTR5-00 | SODECA | - | - | | | | | **100** | **2** |
| | | | **TOTAL** | | | | | **270** | **430** | **800** | **20** |

## Teaching and Examination Scheme
## M. Tech.: Transportation Engineering
## II Semester

| SN | Category | Course | | Contact hrs./ week | | | Marks | | | | Cr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Code | Title | L | T | P | Exam Hrs. | IA | ETE | Total | |
| 1 | PCC | 2MTR1-01 | Pavement Analysis, Design and Construction | 3 | - | - | 3 | 30 | 70 | **100** | **3** |
| 2 | PCC | 2MTR1-02 | Traffic Engineering & Modeling | 3 | - | - | 3 | 30 | 70 | **100** | **3** |
| 3 | PEC | 2MTR2-11 | Transportation-Environment Interaction and Analysis | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 4 | | 2MTR2-12 | Urban Mass Transportation System | | | | | | | | |
| 5 | | 2MTR2-13 | Sustainable Construction Engineering | | | | | | | | |
| 6 | PEC | 2MTR2-14 | Road construction equipment | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 7 | | 2MTR2-15 | Pavement Maintenance and Management System | | | | | | | | |
| 8 | | 2MTR2-16 | Planning, Design and Construction of Rural Roads | | | | | | | | |
| 9 | MCC | 2MCC3-XX | Audit Course-I | 2 | 0 | 0 | | | | | |
| 10 | PCC | 2MTR1-06 | Traffic engineering lab | - | - | 4 | - | 60 | 40 | **100** | **2** |
| 11 | PCC | 2MTR1-07 | Statistical and Numerical analysis lab | - | - | 4 | - | 60 | 40 | **100** | **2** |
| 12 | REW | 2MTR4-50 | Mini project with Seminar | - | - | 4 | - | 60 | 40 | **100** | **2** |
| 14 | SODECA | 2MTR5-00 | Social Outreach discipline & Extra Curriculum Activities | | | | | | | **100** | **2** |
| | | | **TOTAL** | | | | | **300** | **400** | **800** | **20** |

## Teaching and Examination Scheme
## M. Tech.: Transportation Engineering
## III Semester

| SN | Category | Course | | Contact hrs./week | | | Marks | | | | Cr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Code | Title | L | T | P | Exam Hrs. | IA | ETE | Total | |
| 1 | PEC | 3MTR2-11 | Remote sensing and GIS | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| | | 3MTR2-12 | Advanced Concrete Technology | | | | | | | | |
| | | 3MTR2-13 | Ground improvement technique | | | | | | | | |
| 2 | MCC | 3MCC3-XX | Open Elective (Choose from attached list) | 3 | - | - | 3 | 30 | 70 | **100** | **3** |
| 3 | MCC | 3MCC3-XX | Audit Course-II | 2 | 0 | 0 | | | | | |
| 4 | REW | 3MTR4-60 | Dissertation phase I - Industrial project | 0 | 0 | 20 | - | 240 | 160 | **400** | **10** |
| | | | **TOTAL** | | | | | **300** | **300** | **600** | **16** |

## Teaching and Examination Scheme
## M. Tech.: Transportation Engineering
## IV Semester

| SN | Category | Course | | Contact hrs./week | | | Marks | | | | Cr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Code | Title | L | T | P | Exam Hrs. | IA | ETE | Total | |
| 1 | REW | 4MTR4-70 | Dissertation II | 0 | 0 | 32 | - | 360 | 240 | **600** | **16** |
| | | | **TOTAL** | | | | | **360** | **240** | **600** | **16** |

**TRANSPORTATION ENGINEERING**
**1MTR1-01: TRANSPORTATION PLANNING**

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | **Introduction to transportation planning:** Fields of transportation Engineering; System- Environment Ensemble; Transportation planning process; Transportation problems and problem solving process. | 7 |
| 3 | **Transportation data and survey methods:** Type of Transportation data and its sources, Data quantity and quality, Accuracy and Precision, Sampling techniques, sample sizes, Transportation Planning surveys – Documentation searches, Person surveys, Household surveys, In-transit surveys, Road-side surveys, etc. | 8 |
| 4 | **Transportation Modes and Technologies:** Technologies of Transport and System Components, Network Analysis; Minimum Path Algorithms, Path Characteristics, Path-Vehicle Interaction – Discrete Flows and Continuous Flows, Vehicle and its Performance, System Performance, Vehicle and Container, Weight to Volume relation, Terminal Planning, Operational Planning. | 8 |
| 5 | **Four-stage Sequential Planning:** Urban transportation planning process; trip generation, correlation analysis and regression analysis; trip distribution, Growth factor methods and Synthetic methods; modal split models, first generation, second generation, behavioural models; minimum travel path computations; Trip assignments, route assignment, multiple assignment and network assignment. | 8 |
| 6 | **Land use–Transportation Planning:** Urban Forms, mobility and activity hierarchy; accessibility-based early-era models; Lowery's model and its derivatives; Modern era models. | 8 |
| | **Total** | **40** |

**Textbooks:**


1. B. G. Hutchinson, "Principles of Urban Transport Systems Planning" Scripta Book Co., Washington – 1974
2. Anthony J. Richardson, Elizabeth S. Ampt and Arnim H. Meyburg, "Survey Methods for Transport Planning" Eucalyptus Press, Australia- 1995
3. Roy Thomas, "Traffic Assignment Techniques", Avebury Technical, Aldershot, England – 1991


**Reference books:**


1. C A O'Flaherty, ed , "Transport Planning and Traffic Engineering", Butterworth Heinemann, Elsevier, Burlington, MA - 2006
2. C Jotin Khisty and B Kent Lall, "Transportation Engineering – An Introduction", Prentice Hall of India Pvt Ltd., New Delhi -2003

## TRANSPORTATION ENGINEERING
## 1MTR1-02: Advanced Highway Material Characterization

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | **Aggregates:** Classification, physical and strength characteristics, proportioning of aggregates, Aggregate texture and skid resistance, polishing of aggregates. | 7 |
| 3 | **Soil:** Classification, Structural and Constructional problems in soil subgrade, Identification and strength tests, Soil-moisture movement, Sub-soil drainage, Soil stabilization, Characteristics and use of Fly Ash, Bottom ash and Pond Ash | 8 |
| 4 | **Bitumen:** Bitumen sources and manufacturing, Bitumen constituents, structure and Rheology, Mechanical and engineering properties of bitumen, Tests on bitumen, Emulsions, Tar – Properties, types, modifications, Durability of bitumen, Adhesion of bitumen, Modified bitumen. | 8 |
| 5 | **Bituminous Mixes:** Desirable properties of mixes, Design of bituminous mixes, Tests on bituminous mixes, Fillers, Theory of fillers and specifications. Marshall, Hubbard Field & Hveam Methods. | 8 |
| 6 | **Cement Concrete:** Constituents and their requirements, Physical, plastic and structural properties of concrete, Factors influencing mix design, Design of concrete mixes for DLC and PQC with appropriate admixtures like flyash and high range water reducing admixtures etc. | 8 |
| | **Total** | **40** |

**Textbooks:**


1. Krebs, Robert D. And Walker, R. D., "*Highway Materials*", McGraw Hill Book Co., New York-1971
2. Her Majesty's Stationery Office, "*Soil Mechanics for Road Engineers*", Ministry of Transport, Road Research Laboratory, UK- 1966
3. Her Majesty's Stationery Office, "*Bituminous Materials in Road Construction*", Ministry of Transport, Road Research Laboratory, UK -1966
4. Her Majesty's Stationery Office, "*Concrete Roads Design and Construction*", Ministry of Transport, Road Research Laboratory, UK-1966


**Reference books:**


1. Read, J. And Whiteoak, D., "*The Shell Bitumen Handbook*", Fifth edition, Shell Bitumen, Thomas Telford Publishing, London-2003
2. Relevant IRC and IS codes

## TRANSPORTATION ENGINEERING
## 1MTR2-11: RAILWAY, AIRPORTS, PORTS AND HARBOURS

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | Railway: Transportation and its development, Long term operative plans for Indian Railways. Classification of Railway lines and their track standards, Railway terminology, Traction and tractive Resistance, Hauling capacity and tractive effort of locomotives, different Types of Tractions. Permanent Way: Alignment Surveys, Requirement, gauges, track section, Coning of wheels, Stresses in railway track, high speed track. Geometric design of railway track, Gauge, Gradient, speed, super elevation, cant deficiency, Negative super elevation, curves, length of transition curves, grade compensations. | 15 |
| 3 | Airports: Development of Air Transportation in India :, Airport site election. Modern aircraft's. Airport obstructions: Zoning Laws, Imaginary surfaces, Approach and Turning zone, clear zone, vert. Clearance for Highway & Railway. Runway and taxiway design : Windrose, cross wind component, Runway Orientation and confuguration. Basic runway length and corrections, runway geometric design standards. Taxiway Layout and geometric design standards. Taxiway and other areas. Air traffic control : Need, Network, control aids, Instrumental landing systems | 14 |
| 4 | Ports and Harbours: Importance of ports and harbours. Impact on Indian trade and economy, Plan of harbour, various components, jetty, dolphins, bollards, their design and functions. | 10 |
| | **Total** | **40** |

**Textbooks:**

1. Railway Engineering, Saxena;, Dhanpat Rai Publication,
2. Airport Planning & Design, Goyal & Praveen Kumar, Galgotia Publication
3. Harbour, Dock And Tunnel Engineerin, R. Srinivasan ,Charoter publishing house

**Reference books:**

1. Railway Engineering by Rangwala
2. Airport Engineering Planning And Design (Pb 2020) by SAXENA S.C.

## TRANSPORTATION ENGINEERING
## 1MTR2-12: STATISTICAL METHODS IN TRANSPORTATION ENGINEERING

| S.N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | **Probability distributions:** Introduction to probability and random variables, Binomial distribution, Poisson distribution, Geometric distribution, Hyper Geometric distribution, Normal distribution, Log-Normal distribution, Uniform distribution, Exponential distribution, Gamma distribution, Beta distribution, and Weibull distribution. | 7 |
| 3 | **Parameter Estimation and hypothesis Testing:** Random samples, sampling distributions of mean and variance. Point estimators, the method of maximum likelihood, and the method of moments. Confidence interval. Statistical hypothesis tests, Operations characteristic curve. Tests of hypothesis on the mean of a Normal Distribution, Tests of hypothesis on the means of two Normal distributions, The paired t-test, Tests of hypothesis on one variance, Tests of hypothesis for the equality of two variances, The testing of goodness of fit. | 12 |
| 4 | **Design and Analysis of Experiments:** Fundamental assumptions of analysis of variance, single factor experiments, Latin square and Greeco-Latin square designs, Design of experiments with several factors- Two factor factorial experiments. | 10 |
| 5 | **Regression and Correlation Analysis**: Introduction, Bi-Variate Normal distribution and the associated marginal and conditional distributions, estimation and analysis of simple regression models, correlation coefficients, analysis of correlation coefficients, Hypothesis tests associated with regression and correlation coefficients, curvilinear regression models, Multiple regression models, multiple and partial correlation coefficients. Applications should be taken from transportation planning and traffic engineering. | 10 |
| | **Total** | **40** |

**Textbooks:**


1. Hines, W. W. and Montgomery, D. C., et. al.; "Probability and Statistics in Engineering andManagementScience", John Wiley and Sons, New York, (1990).
2. Freund, J. E.; "Mathematical Statistics", PHI, New Delhi, (1998)
3. Montgomery, D. C.; "Design and Analysis of Experiments", 5$^{th}$edition, John Wiley and Sons,INC., New York. (2007).


**Reference books:**


1. Johnston, J. and Dinardo, J.; "Econometric Methods", 4$^{th}$edition, McGraw-Hill InternationalEditions, (1997).
2. Benjamin, J. R. and Cornell, C. A.; "Probability Statistics and Decision for Civil Engineers",McGraw-Hill, (1960).

## TRANSPORTATION ENGINEERING

# 1MTR2-13: ROAD TRANSPORT MANAGEMENT AND ECONOMICS

| SN | Syllabus | Contact hours |
|---|---|---|
| 1 | INTRODUCTION : Objective, scope and outcome of the course | 1 |
| 2 | Motor Vehicles Act - statutory provision for road transport and connected organisations. Route scheduling, Freight transport, Vehicle scheduling, Optimum fleet size, Headway control strategies, Crew scheduling. | 7 |
| 3 | Depots and Terminals - Principles and types of layout, Depot location, Twin depot concept, Crew facilities. Design of parking facilities – Bus terminal, bus stops and bus bays | 8 |
| 4 | Transportation costs - Supply and demand - elasticity of demand; Supply of transport services - Economics of traffic congestion - Pricing policy. Vehicle operating costs - Fuel costs - Maintenance and spares - Depreciation - Crew costs - Value of travel time savings - Accident costs. | 8 |
| 5 | Economic analysis of projects - Methods of evaluation - Cost-benefit ratio, first year rate of return, net present value, and internal-rate of return methods; Indirect costs and benefits of transport projects. | 8 |
| 6 | Financing of road projects - methods – Private Public Partnership (PPP) - Toll collection - Economic viability of Build-Operate-Transfer Schemes – Risk Analysis - Case Studies. | 8 |
| | **Total** | **40** |

**Textbooks:**

1. Winfrey, Economic analysis for Highways, International Textbook Company, Pennsylvania, 1969.

**Reference books:**

1. CRRI, Road User Cost Study in India, New Delhi, 1982

2. IRC, Manual on Economic Evaluation of Highway Projects in India, SP30, 2007

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## TRANSPORTATION ENGINEERING

## 1MTR2-14: MANAGEMENT OF QUALITY AND SAFETY IN HIGHWAY CONSTRUCTION

| SN | Syllabus | Contact hours |
|---|---|---|
| 1 | INTRODUCTION : Objective, scope and outcome of the course | 1 |
| 2 | Total quality Management (TQM) to the construction industry: Evolution, philosophy and principles for building client, the Deming Philip Crosby, J. M. Juran contribution to TQM. Quality as a management process, contractual options and integration. | 7 |
| 3 | TQM to Construction Projects : General application, TQM in pre contract, post contract, commissioning and maintenance phase, Project quality management. | 8 |
| 4 | Auditing: First party auditing, second party auditing, Contraction management adjudication.<br>Accidents: types, causes, direct and indirect cost of accidents, objective of accident prevention programmes. | 8 |
| 5 | Preventative measures: personal protective equipments, job requirements, tools, equipments and fire protection measures. Protection from radioactive,/ toxic material, laser and X-ray equipments. | 8 |
| 6 | Safety Organization and Management: Safety policies, safety organization, safety committees, safety representatives, outside agencies – Govt. intervention, international agreements | 8 |
| **7** | **Total** | **40** |

**Textbooks:**

1. Total Quality in Construction Projects, Ron Baden Hellard ,Thomas Telford, London
2. Engineering Quality in Construction,Michael T Kubal,Mc Graw Hill Inc.

**Reference books:**

1. Handbook of OSHA Construction Safety & Health, Charles D Reese & James V Eidson

## TRANSPORTATION ENGINEERING
## 1MTR2-15: TUNNEL ENGINEERING

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | Historical: Natural caves, archeological caves and their construction, tunnels for road, rail and hydropower. | 9 |
| 3 | Need for Underground Space: Congestion driven needs for development of infrastructure for transport, water, power supply, vehicle movement in cities, storage of materials. | 10 |
| 4 | Modern Developments: Underground ring roads in mega cities, submerged and floating tunnels, underground libraries, museums, dwelling units, resorts. | 10 |
| 5 | Traffic surveillance and control system (TSCS) in tunnels: Traffic control signs, signals, lights, cameras. | 10 |
| | **Total** | **40** |

**Textbooks:**

1. Engineering Geology & Tunnels Engineering, Jaafar Mohammed
2. Tunnel Engineering Handbook, John O. Bickel and T. R. Kuesel, Krieger Publishing Company

**Reference books:**

1. Art of Tunnelling, K. Szechy

## TRANSPORTATION ENGINEERING
## 1MTR2-16: GEOMETRIC DESIGN

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | **Introduction:** Design Controls - Topography and physical features, traffic, vehicular characteristics, speed and safety; Space standards for urban, rural and hill roads, Sight distance requirements, Access controls | 7 |
| 3 | **Cross-section Elements :** Single lane, Two lane, Multi-lane highways, Expressways, Urban roads; Street design concepts, bicycle tracks, pedestrian facilities, street furniture, Design of Speed Breaker | 6 |
| 4 | **Alignment : Horizontal Alignment -** Curve design, Super-elevation design, Transition curve design, Attainment of super-elevation, Pavement widening, Sight distance on horizontal curves; Vertical Alignment - Gradients, Grade compensation, Design of vertical curves, Combination of horizontal and vertical alignment, vertical clearance for underpasses and elevated structures | 6 |
| 5 | **Highway Capacity:** Two lane, Four lane, Six lane non-urban highways, Urban roads, Expressways, HCM USA and IRC Specifications | 6 |
| 6 | **Intersection Geometry:** Visibility requirements, Principles of channelization, Layout design for types of intersections, on-ramps and off-ramps (flyovers and Access controlled facilities), Acceleration and deceleration lanes, Two-way turn lanes | 6 |
| 7 | **Design of Facilities:** Design of on-street and off-street parking facilities, multi-storyed Parking; Design of bus shelters and bus lay-bye, Bus terminal, Truck terminals and truck lay-bye, Container terminal, Toll Plaza, Foot-over bridge and sky-walk | 8 |
| | **Total** | **40** |

**Textbooks:**


1. Wright, P.H. & Dixon, K.K., "Highway Engineering", 7th Ed., John Wiley & Sons. 2004
2. Transportation Research Board (TRB), Highways Capacity Manual, National Research Council, Washington D.C. 2010


**Reference books:**


1. Khisty, C.J. and Lal, B.K., "Transportation Engineering - An Introduction", Prentice Hall of India Pvt. Ltd. 2006
2. Kadiyali, L.R., "Traffic Engineering and Transport Planning", Khanna Publishers. 2008

## TRANSPORTATION ENGINEERING
## 1MCC3-21: RESEARCH METHODOLOGY AND IPR

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations. | 5 |
| 3 | Effective literature studies approaches, analysis, Plagiarism, Research ethics. | 6 |
| 4 | Effective technical writing, how to write report, Paper. Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee. | 6 |
| 5 | Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. | 6 |
| 6 | Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR. | 6 |
| | **Total** | **30** |

**Text books:**


1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science &engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"


**Reference books:**


1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Asimov, "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in NewTechnological Age", 2016.
7. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

## TRANSPORTATION ENGINEERING
## 1MTR1-06: HIGHWAY MATERIAL TESTING LABORATORY

**Course Objectives:**

- To conduct various standard tests on soil, aggregate and bitumen.
- To learn bituminous and concrete mix design

**List of Practical:**

| S. N. | Tests for Characterization anduse of Highway materials |
|---|---|
| 1 | To conduct identification tests on soils; Heavy compaction test on subgrade soil |
| 2 | To perform triaxial test on pure subgrade soil |
| 3 | To perform California Bearing Ratio test |
| 4 | To perform tests on flyash, pondAsh and bottomash- gradation and other engineering properties required for use as embankment material |
| 5 | To perform tests on Bitumen – Penetration Test and Ductility test |
| 6 | To perform tests on Bitumen – Softening point test and Thin Film Oven test |
| 7 | To perform Elastic recovery/recovery test on binder |
| 8 | To conduct Marshall Bituminous Mix design, Bitumen viscosity test (Rotational viscometer);Retained stability test |
| 9 | To perform Concrete Mix design – Sample preparations for DLC and PQC with proper ingredients and admixtures for economy. |
| 10 | To perform PQC Mix design – as per IRC |

**Textbooks:**

**1.** Highway Engineering – S.K. Khanna & C.E.G. Justo. New Chand & Brothers.

**Reference books:**

1. Highway material Testing - S.K. Khanna & C.E.G. Justo.

**TRANSPORTATION ENGINEERING**
**1MTR1-07: PAVEMENT DESIGN LAB**

| **List of Practical:** | |
|---|---|
| **S No.** | **Tests for Pavement design and Evaluation** |
| 1 | To do estimation of Design MSA for a road |
| 2 | To do estimation of Design CBR |
| 3 | To perform Design of flexible pavement |
| 4 | To perform Design of Rigid pavement |
| 5 | To conduct Benkelman Beam test on road |
| 6 | To assess road safety features on a stretch of road |
| 7 | To perform Plate load test for calculating modulus of subgrade reaction |
| 8 | To do estimation of Group Index Value |
| 9 | To study california Resistance Value Method |

**Textbooks:**

1. Highway Engineering – S.K. Khanna & C.E.G. Justo. New Chand & Brothers.

**Reference books:**

1. Highway material Testing - S.K. Khanna & C.E.G. Justo.

## TRANSPORTATION ENGINEERING
## 2MTR1-01: PAVEMENT ANALYSIS, DESIGN AND CONSTRUCTION

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | **Introduction:** Components of pavement structure, importance of sub-grade soil properties on pavement performance. Functions of sub-grade, sub-base, base course and wearing course. | 4 |
| 3 | **Stresses in Flexible Pavements:** Stresses in homogeneous masses and layered systems, deflections, shear failures, equivalent wheel and axle loads. | 5 |
| 4 | **Elements in Design of Flexible Pavements:** Loading characteristics-static, impact and repeated loads, effects of dual wheels and tandem axles, area of contact and tyre pressure, modulus or CBR value of different layers, equivalent single wheel load, equivalent stress and equivalent deflection criterion, equivalent wheel load factors, climatic and environmental factors. | 5 |
| 5 | **Design Methods for Flexible Pavements:** California bearing ratio (CBR), U.S. Navy method. Triaxial method, Mcleod method, Boussinesq's and Burmister's analysis and design method, IRC method for Flexible Pavement Design | 5 |
| 6 | **Rigid Pavements:** Wheel load stresses, Westergaard's analysis, Bradbury's approach Arlington test, Pickett's corner load theory and charts for liquid, elastic and soil of finite and infinite depths of subgrade. IRC Method of rigid pavement design. | 5 |
| 7 | **Temperature Stresses:** Westergaard's and Thomlinson's analysis of warping stresses, Combination of stresses due to different causes, Effect of temperature variation on Rigid Pavements. | 5 |
| 8 | **Reinforced Concrete Slabs:** Prestressed concrete slabs-general details. Design of Tie Bars and Dowel Bars. | 3 |
| 9 | **Road Construction:** Bituminous road construction procedures and specifications, Quality control requirements. Concrete Road construction: Construction methods, Quality control requirements, Joints in cement concrete pavements, reinforced cement concrete road construction. IRC & MORTH recommendations for construction of Bituminous and Concrete roads. Present practices being followed for quality assurance and speedy construction in the country like by NHAI. | 7 |
| | **Total** | **40** |

**Textbooks:**


1. Yoder, E.J. and Witczak, M.W., "Principles of Pavement Design 2nd Ed", John Wiley & Songs, Inc. – 1975
2. O'Flaherty, A. Coleman, "Highways : the Location, Design, Construction and Maintenance of Road Pavements", 4th Ed., Elsevier - 2006
3. Fwa, T.F., "The Hand Book of Highway Engineering", CRC Press Taylor & Francies Group – 2006


**Reference books:**


1. Khanna, S.K. and Justo, C.E.G., "Highway Engineering Nem Chand Jain & Bros, - 2005
2. Papagiannakis, A.T. and Masad, E.A., "Pavement Design and Materials, John Wiley & Sons Inc - 2008

**TRANSPORTATION ENGINEERING**
**2MTR1-02: TRAFFIC ENGINEERING & MODELING**

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | **Introduction:** Elements of traffic engineering, issues for traffic engineers; road users, vehicles, highways and control devices, modelling concepts. | 6 |
| 3 | **Traffic Stream Characteristics**: Traffic stream parameters, Time Space diagram, relationship among q,k,u, Macroscopic Fundamental Diagrams (MFD). | 6 |
| 4 | **Traffic Studies:** Traffic volume studies, speed, travel time and delay studies, parking studies, RSI Survey, WTP Survey, accident data collection and analysis, pedestrian studies | 6 |
| 5 | **Design concept for intersection & facilities**: Concept of capacity and LOS, Operational analysis of two-way and all-way stop controlled intersections and Roundabouts by US and Indian methods, design of parking facilities, types of signals, Design of signals by Indian, US and British methods, signal coordination. | 9 |
| 6 | **Time Series Analysis:** Basic Components of Time Series, Smoothening and Decomposition Methods, Data Filters, Auto Correlations and Moving Averages. | 6 |
| **7** | **Management Techniques:** Traffic calming; Congestion and road user pricing; priority movements; traffic regulations and control systems; use of intelligent systems. | 6 |
| | **Total** | **40** |

**Textbooks:**


1. William R. Mcshane and Roger P. Roess, "Traffic Engineering", Pearson (4th Edition). 2013
2. Kadiyali, L.R., "Traffic Engineering and Transport Planning", Khanna Publishers. 2012
3. C A O'Flaherty, Ed , "Transport Planning and Traffic Engineering", ButterworthHeinemann, Elsevier, Burlington, MA2006


**Reference books:**


1. May, A.D., "Fundamentals of Traffic Flow", Prentice Hall, Inc. 2nd Ed. 1990
2. Carlos F. Daganzo. "Fundamentals of Transportation and Traffic Operations", Pergamon 1997
3. Simon P. Washington, Matthew G. Karlaftis and Fred L. Mannering, "Statistical and Econometric Methods for Transportation Data Analysis", 2nd Edition, CRC Press2011

## TRANSPORTATION ENGINEERING
## 2MTR2-11: TRANSPORTATION ENVIRONMENT INTERACTION AND ANALYSIS

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | **Introduction:** Interaction of transportation systems and facilities with surrounding environment, Impact of transportation on surrounding environment, impact of surrounding environment on transportation systems. | 7 |
| 3 | **Impact on Natural Environment:** Air quality impacts - sources of air pollutants, effects of air pollutants, key legislations and regulations, impact prediction approaches, identification and incorporation of mitigation measures; Noise Impacts - Basic information, key legislation and guidelines, impact prediction methods, identification and incorporation of mitigation measures, Noise barriers and their design; Ground water and marine pollution impacts; Environmental capacities of streets, Environmental Impact statements. | 8 |
| 4 | **Impact on Land Use and Value:** Conceptual approach for addressing socio-economic impacts; Visual impacts and criteria, scoring methodologies for visual impact analysis; Relocation impacts; Land value impacted due to transportation facility; Spatial reorganization and Regional Development impacts. | 8 |
| 5 | **Environmental Impact Analysis:** Concepts of environmental impact analysis, key features of National environmental policy act and its implementation, screening in the EIA process, utility and scope of EIA process, Environmental protection acts EIA at national level, Conceptual approach for environmental impact studies, planning and management of impact studies, matrix and network methodologies for impact identification, description of the affected environmental – environmental indices; Public Participation – Objectives, and techniques for conflict management and dispute resolution, verbal communication in EIA studies . | 8 |
| 6 | **Energy Issues in Transportation:** Energy consumption, alternate transportation fuels, energy conservation, energy contingency strategies, energy analysis information and methods, Transportation alternatives. | 8 |
| | **Total** | **40** |

**Textbooks:**


1. CANTER, L.W., Environmental impact assessment, McGraw-Hill, 1997
2. Peter Morris & Riki Therivel, Methods of Environmental Impact Assessment, Routledge, 2001.
3. Denver Tolliver, Highway Impact Assessment, Greenwood Publishing Group, 1993.
4. Edward K Morlok, Introduction to transportation Engineering and Planning, Mc-Graw Hill Book Company, New Delhi


**Reference books:**


1. John W. Dickey and others, Metropolitan Transportation Planning, Tata McGraw-Hill Publishing Compant Ltd., New Delhi
2. C. Jotin Khisty and B Kent lall, Transportation Engineering – An introduction, Prentice-Hall of India Pvt Ltd, New Delhi.

## TRANSPORTATION ENGINEERING

## 2MTR2-12: URBAN MASS TRANSPORTATION SYSTEM`

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | **Introduction:** Mass transit systems, Elements / components of transit systems; Urban Mass Transit systems- types, characteristics, suitability and adaptability of these systems; Evolution of urban transportation. | 5 |
| 3 | **Transit System Planning:** Planning needs; Short-range and long-range planning; Planning procedures and methodology, Data collection; Medium performance transit systems and high performance transit systems; trends in transit planning | 6 |
| 4 | **Transit Demand Estimation and Evaluation:** Transit demand forecasting; transit mode evaluation; comparison and selection of most suitable transit mode. | 6 |
| 5 | **Transit System Operations:** Basic operational elements; transit travel characteristics; transit scheduling; transit line analysis – planning objectives, geometry, types and their characteristics, capacity of transit lines, system procedures for improving transit line capacity. | 6 |
| 6 | **Transit Networks and System Analysis:** Transit networks – types and their characteristics; transfers in transit networks; system analysis in transit – conceptual models, modeling procedures; terminal or station location planning – issues, objectives, station spacing decisions. | 6 |
| 7 | **Economics and Financing of Transit Systems:** Transit system performance and economic measures; transit fares – structure, collection and levels; financing of transit services; public and private integration of transit services. | 6 |
| 8 | **Case studies of urban mass transportation systems adopted in India in recent years including Delhi Metro, Jaipur Metro, metro bus service, mono rail etc.** | 4 |
| | **Total** | **40** |

**Textbooks:**


1. Vukan R. Vuchic, “Urban Transit – Operations, Planning and Economics”, John Willey and Sons, Inc., USA - 2004
2. Vukan R. Vuchic, “Urban Transit – Operations, Planning and Economics”, John Willey and Sons, Inc., USA - 1980
3. Vukan R. Vuchic, “Urban Transit – Operations, Planning and Economics”, John Willey and Sons, Inc., USA -2006


**Reference books:**


1. C Jotin Khisty and B Kent Lall, “Transportation Engineering” PrenticeHall of India Pvt Ltd., New Delhi - 2003

## TRANSPORTATION ENGINEERING
## 2MTR2-13: SUSTAINABLE CONSTRUCTION ENGINEERING

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | Fundamentals of Sustainable Construction Engineering- Sustainability and resources, need, present practices at national and international level, The Sustainability Quadrant- challenges & Issues, Government initiatives | 7 |
| 3 | Construction Product, Process Design and Development- Sustainability of construction resources, process modifications, product performance evaluation. | 8 |
| 4 | Sustainability assessment using standard approaches- LEED/GRIHA rating evaluation process. | 8 |
| 5 | Socio-economic feasibility of sustainable construction products- Innovative & customized sustainable product design based on social constraints, tools & aids available for sustainable construction products. | 8 |
| 6 | Life Cycle Assessment and Costing-Various aspects related to construction cost, present value analysis, life cycle stages, cost calculation & measures, evaluation criteria, uncertainty assessment, sensitivity analysis, break even analysis. | 8 |
| | **Total** | **40** |

**Textbooks:**


1. Sustainable Engineering Practice ASCE Publication 2010.
2. Hagger Sustainable Industrial Design and Waste Management, Techniz Book 2010.
3. Helmut Rechberger, Practical handbook of Material Flow Analysis, Taylor & Francis. 2010


**Reference books:**


1. Michael Z. Hou, Heping Xie, Jeoungseok Yoon Underground Storage of CO2 and Energy Taylor & Francis, 2010
2. LEED for India: Reference Guide, 2011.

## TRANSPORTATION ENGINEERING

## 2MTR2-14: ROAD CONSTRUCTION EQUIPMENT

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | **Introduction:** Working principle, capacity, rate of production, applications, advantages and limitations of various types of construction equipment | 7 |
| 3 | **Equipment for earthwork excavation, hauling and spreading :** Dozers; power shovels, Scrappers, Tippers and trucks, Motor graders, - application, types, production capacity, factors affecting production, optimum number of equipments for construction. Different types of soil compactors and their applications | 8 |
| 4 | **Plants for aggregates production** – different types of crushers, Mixing plants: Pug mill for WMM, other cold mix plants, Hot mix Plants for bituminous mixes; factors affecting production capacity, Optimum number and location. Mixing plants for cement concrete | 8 |
| 5 | **Paving and compacting equipment:** Different types of pavers and compacting equipment for bituminous mixes, Fixed form type paver and Slip form type paver for CC pavements –their advantages<br>**Miscellaneous Equipment:** Kerb casting equipment, road marking equipment, bitumen sprayers, water tankers | 8 |
| 6 | **Equipment Management:** Equipment planning, forecasting equipment requirement, maintenance, workshop, work study, Selection of Construction Equipment – task considerations, cost considerations, equipment acquisition options | 8 |
| | **Total** | **40** |

**Textbooks:**

1. Peurifoy/ Schexnayder "Construction Planning, Equipment and Methods"- McGraw-Hill Higher Education
2. Sharma S.C. "Construction Equipment and its Management"- Khanna Publishers, Delhi

**Reference books:**

1. K.K. Chitkara, "Construction Project Management,-Planning, Scheduling and Controlling"- Tata McGraw –Hill Publications
2. "Operation Manuals of various equipment manufacturers".

## TRANSPORTATION ENGINEERING
## 2MTR2-15: PAVEMENT MAINTENANCE AND MANAGEMENT SYSTEM

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | **Pavement Evaluation and Performance:** General concept of pavement evaluation, evaluation of pavement performance, evaluation of pavement structural capacity, evaluation of pavement distress, evaluation of pavement safety. | 5 |
| 3 | **Types of Distress:** Structural and functional, serviceability, fatigue cracking, pavement deformation and behaviour in flexible and rigid pavements. Low temperature shrinkage cracking, Factors affecting performance, relation between performance and distress. | 6 |
| 4 | **Pavement Evaluation & Measuring Equipments:** Functional & Structural Evaluation, Functions Parameters such as Roughness, Distress, Rutting, Skid Resistance etc. Structural Parameters such as Structural Capacity. Benkelman Beam, Bump Integrators of various types, dynaflect. Demonstration of equipments for dynamic testing of pavements. Digital ultrasonic concrete tester. Radiographic and infra red testing. Pavement skid resistance measuring equipments, fatigue testing equipments, on-site and on- line testing with sensors, strain-gages LVDTs and data acquisition system. | 8 |
| 5 | **Pavement Overlays:** Flexible overlays and determination of overlay thickness. Rigid overlays and determination of overlay thickness including thin toppings. Design of Overlay by Benkelman Beam and Falling Weight Deflect meter. | 4 |
| 6 | **Design Alternatives –** Analysis, Evaluation and Selection: Framework for pavement design, design objectives and constraints, Basic structural response models, characterization of physical design inputs, Generating alternative pavement design strategies. Economic evaluation of alternative pavement design strategies, analysis of alternative design strategies. Predicting distress, predicting performance, selection of optimal design strategies. | 8 |
| 7 | **Pavement Management System:** Introduction to Pavement Management System (PMS) & Maintenance Management System (MMS), construction, maintenance and rehabilitation. Feedback data system. Examples of Working Design and Management Systems. Implementation of a pavement management system. | 8 |
| | **Total** | **40** |

**Textbooks:**


1. Hass, R., Hudson, W.R. and Zaniewski, J. "Modern Pavement Management" Krieger.-1994
2. Fwa, T.F., "The Hand Book of Highway Engineering", CRC Press, Taylor & Francies Group.-2006
3. Shain, M.Y., "Pavement Management for Airports, Roads and Parking Lots", Kluwer Academic Publishers Group-2004
4. Khanna, S.K. and Justo, C.E.G., "Highway Engineering" Nem Chand & Bros, Roorkee (U.A.) 8th Ed. -2005


**Reference books:**


1. Hudson, W.R., Haas, R. and Uddin, W., "Infrastructure Management", McGraw Hill -1997
2. Hass R. & Hudson, W.R., "Pavement Management System", Mc Graw Hill Company, Inc. New York -1978

## TRANSPORTATION ENGINEERING
## 2MTR2-16: PLANNING, DESIGN AND CONSTRUCTION OF RURAL ROADS

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | **Planning of Rural Roads:** Classification of Roads, Brief introduction to earlier 20 year Plans, System's Approach, NATPAC Model, Gravity Model, CRRI Model, FBRNP Model, Concepts of PMGSY | 5 |
| 3 | Geometric Design: Geometric Design Standards for Rural Roads with special reference to PMGSY, Hill Road Standards | 4 |
| 4 | **Pavement Design**: Various pavement design methods for Rural roads including Flexible and Rigid pavements using IRC:SP-20, IRC-72, IRC-37, IRC:SP-62, CRRI Nomograms | 4 |
| 5 | **Mix Design Methods:** CRRI Method, Triangular Chart Method, Fuller's Method, Rothfuch method, PI based Method | 4 |
| 6 | **Materials:** Brief introduction to conventional materials, Marginal and Waste Materials including Fly Ash, GBFS, BFS, SMS, Bagasse, CRMB, etc | 4 |
| 7 | **Construction:** Case Studies of Waste Material Utilization in Rural Roads, Low Cost Techniques for Rural Road Construction, Tractor Bound Technology, Special Considerations for Hill Areas | 8 |
| 8 | **Drainage:** Transverse and Longitudinal Drainage, Design of drains, Minor CD Works, Filter Design etc | 6 |
| 9 | **Maintenance:** Type and Causes of Failures, Remedies | 4 |
| | **Total** | **40** |

**Textbooks:**


1. Khanna S.K., Justo C.E.G, "Highway Engineering", Nem Chand & Bros, Roorkee- 2004
2. L R Kadiyali, "Traffic Engineering and Transport Planning", Khanna Publishers, Delhi - 1999
3. Quality Assurance Handbook for Rural Roads, NRRDA, Govt. of India – 2007


**Reference books:**


1. Rural Roads Manual , SP-20, IRC - 2002
2. Document on Rural Road Development, Vol I & II, CRRI -1990
3. PMGSY Operation Manual, NRRDA, Govt of India -2005
4. Specifications for Rural Roads, MoRD, IRC -2004

## TRANSPORTATION ENGINEERING
## 2MTR1-06: TRAFFIC ENGINEERING LAB

| S. No. | The experiments may include: |
|---|---|
| 1 | To conduct Traffic volume data collection at midblock section in urban area and its analysis |
| 2 | To conduct Traffic volume data collection at rural highway section and its analysis |
| 3 | To conduct Categorized vehicle speed data collection at urban and rural sections and its analysis |
| 4 | To Derive flow relationships between flow characteristics based on volume and speed data collected |
| 5 | To do Speed and delay study using Moving observed method |
| 6 | To peform Volume study at a roundabout to examine its capacity |
| 7 | To perform Volume and speed study at a four legged intersection |
| 8 | To perform Parking study in a market or commercial area (accumulation and duration analysis) |
| 9 | To Analysis accident data procured from police stations |

**TRANSPORTATION ENGINEERING**
**2MTR1-07: STATISTICAL AND NUMERICAL ANALYSIS LAB**

| S No. | The experiments/activities may include: |
|---|---|
| 1 | To study Newton's forward interpolation method |
| 2 | To study Newton's backward interpolation method |
| 3 | To study Lagrange's interpolation method |
| 4 | To study Newton Raphson method |
| 5 | To determine Solution of ODE by Runge-Kutta method |
| 6 | To perform Calculation of eigen values and eigen vector method |
| 7 | To Analysis variance and application |
| 8 | To study Linear regression analysis and their application |
| 9 | To study Multiple regression analysis and their application |

**TRANSPORTATION ENGINEERING**
**2MTR4-50: MINI PROJECT WITH SEMINAR**

| S No. | Some suggested topics are: |
|---|---|
| 1 | To Study and perform evaluation of an intersection in a city |
| 2 | To Study and evaluate mode of transport in a city |
| 3 | To Study accidents in a city and remedial measures |
| 4 | To conduct study on Futuristic transportation planning |
| 5 | To analysis Parking pattern of a given area |
| 6 | To conduct Study of congestion and to suggest remedial measures |
| 7 | To Study various road safety measures adopted |

Note: The student can take real time problem, collect data, analyze and present in a seminar.
Latest developments in the area of transportation can be studied from literature and presented in the form of seminar.

## TRANSPORTATION ENGINEERING
## 3MTR2-11: Remote sensing and GIS

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | **Introduction: Definitions of GIS** – Components of GIS – Geographic data presentation: maps – mapping process – coordinate systems – transformations – map projections – geo referencing - data acquisition. | 9 |
| 3 | **Geographic Data Representation, Storage, Quality and Standards**: Storage - Digital representation of data – Data structures and database management systems – Raster data representation – Vector data representation – Concepts and definitions of data quality – Components of data quality – Assessment of data quality – Managing data errors – Geographic data standards. | 10 |
| 4 | **GIS Data Processing, Analysis and Modeling:** Raster based GIS data processing – Vector based GIS data processing – Queries – Spatial analysis – Descriptive statistics – Spatial autocorrelation – Quadrant counts and nearest neighbour analysis – Network analysis – Surface modeling – DTM. | 10 |
| **5** | **GIS Applications:** Applications of GIS in Environment monitoring – Natural hazard management, Transport Planning, Analysis and monitoring. Use of softwares related to GIS applications in Transportation Engineering. | 10 |
| | **Total** | **40** |

**Text books:**


1. Lo, C.P. & Yeung A.K.W., Concepts and Techniques of Geographic Information Systems, Prentice Hall of India, New Delhi, 2006.
2. Anji Reddy, M., Remote Sensing and Geographical Information Systems, B.S.Publications, Hyderabad, 2001.
3. Burrough, P.A., Principles of Geographical Information Systems, Oxford Publication, 1998.
4. Clarke, K., Getting Started with Geographic Information Systems, Prentice Hall, New Jersy, 2010.
5. DeMers, M.N., Fundamentals of Geographic Information Systems, John Wiley & Sons, New York, 2002.


**Reference books:**


1. Geo Information Systems – Applications of GIS and Related Spatial Information Technologies, ASTER Publication Co., Chestern (England), 1992
2. Jeffrey, S. & John E., Geographical Information System – An Introduction, Prentice-Hall, 1990
3. Marble, D.F., Galkhs HW & Pequest, Basic Readings in Geographic Information Systems, Sped System Ltd., New York, 1984.

## TRANSPORTATION ENGINEERING
## 3MTR2-12: ADVANCED CONCRETE TECHNOLOGY

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | **Cement:** composition and reaction mechanism | 4 |
| 3 | **Concrete containing cementitious material:** Use of fly ash, silica fume and GGBFS in concrete, reaction mechanism, properties of fresh and hardened concrete | 8 |
| 4 | **Structural Concrete:** High Strength concrete, high performance concrete, Self-compacting concrete, ready mix concrete, polymer concrete: materials, admixtures, applications and properties of fresh and hardened concrete | 8 |
| 5 | **Fiber Reinforced Concrete**: constituent materials and properties, mechanics of fiber reinforced concrete, properties of fresh and hardened concrete | 7 |
| 6 | **Durability of concrete:** Carbonation, chloride ingress, corrosion, sulphate attack, freezing and thawing: Factors affecting, effects, mechanisms, prevention and control | 6 |
| 7 | **Creep and Shrinkage**: Factors affecting, effects, mechanisms, prevention and control | 6 |
| | **Total** | **40** |

**Text Books:**

1. A.M. Neville, “Properties of Concrete”, Pearson Education, 1995

2. A.M. Neville & J.J. Brooks, “Concrete Technology”, Addison- Wesley, 1999

**Reference books:**

1. P.K. Mehta & P.J.M. Monterio, “Concrete”, ICI, 1999

## TRANSPORTATION ENGINEERING
## 3MTR2-13: GROUND IMPROVEMENT TECHNIQUE

| S. N. | Course Content | Contact Hours |
|---|---|---|
| 1 | **INTRODUCTION :** Objective, scope and outcome of the course | 1 |
| 2 | **Introduction:** Typical situations where ground improvement becomes necessary, Historical review of methods adopted in practice, Current status and the scope in the Indian context. | 7 |
| 3 | **Methods of Ground Improvement:** Mechanical compaction, Dynamic compaction, Impact loading, Compaction by blasting, Vibro-compaction; Pre-compression, Dynamic consolidation, Design aspects of stone columns; Use of admixtures, Injection of grouts; Design guidelines and quality control, Design examples on preloading with sand drains, Road designs with Geo-synthetics. | 8 |
| 4 | **Reinforced Earth:** Basic mechanism, Constituent materials and their selection; Engineering applications – Shallow foundations on reinforced earth, Design of reinforced earth retaining walls, Reinforced earth embankments structures, Wall with reinforced backfill, Analysis and design of shallow foundations on reinforced earth. | 8 |
| 5 | **Geo-textiles:** Selection and engineering applications, Design examples, Stabilisation/Improvement of ground using Geo-membranes, Geo-cells, Geonets, Geosynthetic walls. | 8 |
| 6 | **Soil Nailing:** Construction of underground structures, Landslide controls, Deep vertical cuts, contiguous piles. | 4 |
| 7 | **Problematic Soils:** Use of ply soils, Improvement of saline soils, Improvement of black cotton soils, Collapsible soil, Dune Sand. | 4 |
| | **Total** | **40** |

### Text Books:


1. Moseley, M. P. and Kirsch K.," Ground Improvement", Spon Press, Taylor and Francis2004
2. Mittal, Satyendra, "Ground Improvement Engineering", Vikas Publishing House 2010
3. Koerner, R.M.," Designing with Geosynthetics"' Prentice Hall 1990
4. Saran, S., "Reinforced Soil and Its Engineering Applications", I.K. International 2005


### Reference books:


1. Rao, G.V., Geosynthetics – An Introduction, Sai Master Geoenvironmental Services(P) Ltd. 2007
2. Jones, CJFP, "Earth Reinforcement and soil structure", Thomas Telford 1996
3. Shukla, S.K., Yin, Jian-Hua, "Fundamentals of Geosynthetic Engineering", Taylor & Francis