

**ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS**

**M.TECH.
HIGHWAY ENGINEERING**

(Applicable for the batches admitted from 2011-2012)



**VNR VIGNANA JYOTHI
INSTITUTE OF ENGINEERING & TECHNOLOGY
(AFFILIATED TO JNTUH)
*An Autonomous Institute under JNTUH***

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Academic Regulations 2011 For M.Tech. Degree Course (Effective for the students admitted into first year from the academic year 2011-2012)

1. Introduction

Academic Programmes of the institute are governed by rules and regulations as approved by the academic council of the institute.

These academic rules and regulations are effective from the academic year 2011-12, for the students admitted into two year post graduate programme offered by the college leading to Master Of Technology (M. Tech.) degree in the disciplines viz., Civil Engineering, Electrical and Electronics Engineering, Mechanical Engineering, Electronics and Communication Engineering, Computer science and Engineering, Information Technology, Electronics and Instrumentation Engineering and Automobile Engineering.

The M.Tech. Degree of Jawaharlal Nehru Technological University Hyderabad shall be conferred on candidates who are admitted to the program after fulfilling all the requirements for the award of the Degree.

1.1 Eligibility for Admissions

Admission to the above program shall be made subject to the eligibility, qualifications and specialization prescribed by the University from time to time. Admissions shall be made on the basis of GATE Rank and merit rank obtained by the qualifying candidate at an Entrance Test conducted by the University, subject to reservations prescribed by the university/ State Government from time to time.

2. Courses of Study

The following specializations are offered at present for the M.Tech. Course of study.

1. Advanced Manufacturing Systems
2. Highway Engineering
3. Structural Engineering
4. Power Electronics
5. Software Engineering
6. VLSI System Design
7. Embedded Systems
8. Geotechnical Engineering
9. Electronic Instrumentation
10. Automation

and any other course as approved by the Academic Council of the Institute and the authorities of the University from time to time.

2.1 Departments offering M.Tech. Programmes with specializations are mentioned below:

ME	1. Advanced Manufacturing Systems 2. Automation
CE	1. Highway Engineering 2. Structural Engineering 3. Geotechnical Engineering
EEE	Power Electronics
CSE	Software Engineering
ECE	1. VLSI System Design 2. Embedded Systems
EIE	Electronic Instrumentation

3. Attendance

Each academic year shall be divided into two semesters, each of 90 instructional days, excluding examination, evaluation, declaration of results etc.

- 3.1 A candidate shall be deemed to have eligibility to write end semester examinations in a subject if he has put in at least 75% of attendance in that subject.
- 3.2 Shortage of attendance up to 10% in any subject (i.e. 65% and above and below 75%) may be condoned by the College Academic Committee on genuine and valid reasons on application by the candidate with supporting evidence.
- 3.3 A candidate shall get minimum required attendance at least in three (3) theory subjects in the present semester to get promoted to the next semester. In order to qualify for the award of the M.Tech. Degree, the candidate shall complete all the academic requirements of the subjects, as per the course structure.
- 3.4 Shortage of attendance below 65% shall in no case be condoned.
- 3.5 A stipulated fee shall be payable towards condonation of shortage of attendance.
- 3.6 In case the candidate secures less than the required attendance in any subject(s), he shall not be permitted to appear for the End Examination in that subject(s). He shall re-register the subject when next offered.

4. Evaluation

The performance of the candidate in each semester shall be evaluated subject-wise, with a maximum of 100 marks for theory and 100 marks for practicals, on the basis of Internal Evaluation and End Semester Examination.

- 4.1 For the theory subjects 60 marks shall be awarded based on the performance in the End Semester Examination, 40 marks shall be awarded based on the Internal Evaluation. The internal evaluation shall be made based on the better of the marks secured in the two Mid Term-Examinations conducted one in the middle of the Semester and the other immediately after the completion of instruction. Each mid term examination shall be conducted for duration of 2 Hours with 4 questions to be answered out of 6 questions.

- 4.2** For practical subjects, 60 marks shall be awarded based on the performance in the End Semester Examinations, 40 marks shall be awarded based on the day-to-day performance as Internal Marks.
- 4.3** There shall be two seminar presentations during the I year, one in each semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the Department in a report form and shall make an oral presentation before the Departmental Committee. The Departmental Committee consists of Head of the Department, supervisor and two other senior faculty members of the department. For each Seminar there will be only internal evaluation of 50 marks. A candidate has to secure a minimum of 50% to be declared successful.
- 4.4** There shall be a Comprehensive Viva-Voce in II year I Semester. The Comprehensive Viva-Voce will be conducted by a Committee consisting of Head of the Department and two Senior Faculty members of the Department. The Comprehensive Viva-Voce is aimed to assess the students' understanding in various subjects studied during the M.Tech. course of study. The Comprehensive Viva-Voce is valued for 100 marks by the Committee. There are no internal marks for the Comprehensive viva-Voce.
- 4.5** A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the End Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.
- 4.6** A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate are less than 50% and he has failed in the end examination. In such a case candidate may re-register for the subject(s) and secure required minimum attendance. Attendance in the re-registered subject(s) has to be calculated separately to become eligible to write the end examination in the re-registered subject(s). Re-registration for the subjects is allowed only if that particular re-registration subjects are the hindrance for the award of Degree. Re-registration is allowed in this case provided the student doesn't have any subject(s) yet to pass other than the re-registration subjects with prior permission.
- 4.7** Laboratory examination for M.Tech. courses must be conducted with two Examiners, one of them being Laboratory Class Teacher and second examiner shall be a teacher of same specialization either external or from the same dept.
- 5. Evaluation of Project / Dissertation Work.**
- 5.1** Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects (theory and practical subjects).
- 5.2** A Project Review Committee (PRC) shall be constituted with at least four members namely HOD, PG Coordinator of the Department, project supervisor and one senior faculty member of same specialization.
- 5.3** After satisfying 5.1, a candidate has to submit, in consultation with the project supervisor, the title, objective and plan of action of his project work to the Departmental Academic Committee for its approval. Only after obtaining the approval of Departmental Academic Committee, the student can initiate the Project work.

- 5.4** If a candidate wishes to change his supervisor or topic of the project he can do so with the approval of Departmental Academic Committee. However, the Departmental Committee shall examine whether the change of topic/supervisor leads to a major change of his initial plans of project proposal. If so, his date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.
- 5.5** Internal Evaluation of the project shall be on the basis of the seminars(Project reviews) conducted during the II year by the committee consisting of Head of the Department, project supervisor ,PG coordinator of the Department and senior faculty member of the Department. belonging to same specialization. A candidate shall submit status report in a spiral bound copy form.
- 5.6** The work on the project shall be initiated in the beginning of the second year and the duration of project is for two semesters. A candidate is permitted to submit Project Thesis only after successful completion of theory and practical course with the approval of PRC not earlier than 240 days from the date of registration of the project work. For the approval of PRC the candidate shall submit the draft copy of thesis to the Head of the Department (Through project supervisor/PG coordinator) and shall make an oral presentation before the PRC.
- 5.7** After approval of PRC, every student has to submit three copies of the Project Thesis certified by the supervisor to the Department.
- 5.8** The thesis shall be adjudicated by one examiner selected by the Chief Superintendent. For this, HOD shall submit a panel of 3/ 5 examiners, who are eminent in that field with the help of the concerned guide.
- 5.9** If the report of the examiner is not favourable, the candidate shall revise and resubmit the Thesis, within the time frame as described by PRC. If the report of the examiner is unfavourable again, the thesis shall be summarily rejected.
- 5.10** If the report of the examiner is favorable, viva-voce examination shall be conducted by a board consisting of the supervisor, Head of the Department and the examiner who adjudicated the Thesis. The Board shall jointly report candidates work as:
- A. Excellent
 - B. Good
 - C. Satisfactory
 - D. Unsatisfactory

Head of the Department shall coordinate and make arrangements for the conduct of viva-voce examination. The candidate has to secure any one of the grades as Excellent, Good or Satisfactory on his thesis/dissertation and viva-voce. If the report of the viva-voce is unsatisfactory, the candidate will retake the viva-voce examination after three months. If he fails to get a satisfactory report at the second viva-voce examination, he has to reregister the project work as in clause 5.1. However, the candidate may select a new guide and new topic with the approval of the PRC and submit the project report with a minimum of 240 days from the date of re-registration. Of course this shall not prejudice the clause 6.1 below. The candidate can be permitted to change the topic/guide only once.

6. Award of Degree and Class

A student shall be declared eligible for the award of the M.Tech. degree, if he pursues a course of study and completes it successfully for not less than two academic years and not more than four academic years.

- 6.1 A student, who fails to fulfil all the academic requirements for the award of the degree within four academic years from the year of his admission, for any reason whatsoever, shall forfeit his seat in M.Tech. Course.
- 6.2 After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree shall be placed in one of the following four classes:

Class Awarded	% of marks to be secured
First Class with Distinction	70% and above
First Class	Below 70% but not less than 60%
Second Class	Below 60% but not less than 50%

(The marks in internal evaluation and end examination shall be shown separately in the marks memorandum)

7. Withholding of Results

If the candidate has not paid any dues to the Institute or if any case of indiscipline is pending against him, the result of the candidate will be withheld and he will not be allowed into the next higher semester. The issue of the degree is liable to be withheld in such cases. This delay shall not prejudice clauses Nos.6.0 and 6.1

8. Transitory Regulations

Candidate who have discontinued or have been detained for want of attendance or who have failed after having undergone the course are eligible for admission to the same or equivalent subjects as and when subjects are offered without precluding clauses Nos.6.0 and 6.1

9. General

- 9.1 The academic regulations should be read as a whole for purpose of any interpretation.
- 9.2 In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Principal is final.
- 9.3 The Institute may change or amend the academic regulations and syllabi at any time and the changes and amendments made shall be applicable to all the students with effect from the date notified by the Institute.
- 9.4 Wherever the words he, him or his occur, they will also include she, her and hers.

10. Supplementary Examination

Supplementary examinations will be conducted along with regular semester end examinations. Supplementary examinations will be conducted to a maximum number of four continuous times subsequent to the revision of the syllabus. Supplementary examinations will be conducted in the equivalent courses as approved by the Institute Academic Committee.

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

M.TECH. (HIGHWAY ENGINEERING)

I YEAR I SEMESTER

COURSE STRUCTURE

Subject Code	Group	Subject Name	L	P	Credit
R11HIG2101		Highway Infrastructure Engineering	3	0	3
R11HIG2102		Highway Project Formulation & Economics	3	0	3
R11HIG2103		Traffic Engineering	3	0	3
R11HIG2104		Pavement Analysis & Design	3	0	3
R11HIG2105	Elective – I	Applied Statistics.	3	0	3
R11HIG2106		Project Management.			
R11HIG2107		Principles of Bridge Engineering.			
R11HIG2108	Elective – II	Road Safety & Traffic Management	3	0	3
R11HIG2109		Concrete Technology.			
R11HIG2110		Environmental impact Assessment for Transportation Projects			
R11HIG2201	Lab	Highway Engineering Lab – I	0	3	2
R11HIG2301		Seminar	-	-	2
Total Credits (6 Theory + 1 Lab)					22

I YEAR II SEMESTER

COURSE STRUCTURE

Subject Code	Group	Subject Name	L	P	Credit
R11HIG2111		Pavement Management System	3	0	3
R11HIG2112		Urban Transportation Planning	3	0	3
R11HIG2113		Highway Construction & Quality Control	3	0	3
R11HIG2114		Remote Sensing & GP			
R11HIG2115	Elective – III	Rural Roads.	3	0	3
R11HIG2116		Evaluation and Strengthening of Pavements.			
R11HIG2117		Ground Improvements Technique.			
R11HIG2118	Elective – IV	Advance Modeling Techniques in Highway Engineering	3	0	3
R11HIG2119		Airport Planning & Design			
R11HIG2120		GIS Application In Transportation Engineering			
R11HIG2202	Lab	Highway Engineering Lab – II	0	3	2
R11HIG2302		Seminar	-	-	2
Total Credits (6 Theory + 1 Lab)					22

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

M.TECH. (HIGHWAY ENGINEERING)

II YEAR – I SEMESTER

COURSE STRUCTURE

Subject Code	Group	Subject Name	L	P	Credits
R11HIG2303		Comprehensive Viva	-	-	2
R11HIG2304		Project Seminar - I	0	3	2
R11HIG2305		Project Work	-	-	18
Total Credits					22

II YEAR – II SEMESTER

COURSE STRUCTURE

Subject Code	Group	Subject Name	L	P	Credits
R11HIG2306		Project Work	0	0	20
R11HIG2307		Project Seminar – II	0	0	2
Total Credits					22

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

I Year – I Sem. M.Tech. (Highway Engineering)

L	T/P/D	C
3	0	3

(R11HIG2101)HIGHWAY INFRASTRUCTURE ENGINEERING

Unit I

Functional Classification of Highway System; Design Controls – Topography, Driver characteristics, Vehicle Characteristics, Traffic, Capacity and Level of Service, Design Speed. Objectives of Geometric Design, Cross Section Elements: Design specifications; Pavement Surface characteristics – Skid Resistance, Road Roughness; Camber, Objectives, design standards. Specifications for hill roads

Unit II

Horizontal Alignment and Vertical Alignment of roads: Sight Distances – Stopping Sight Distance, Overtaking Sight Distance and Intermediate Sight Distance ; Objectives of horizontal curves; Super elevation; Extra- widening on Curves; Transition Curves – Objectives and Design. Transition Curve setting methods and calculations , Introduction to MX Roads software ; Vertical Alignment : Gradients – Types of Gradients, Design Standards; Vertical Curves – Summit Curves, Valley Curves and Design criteria for Vertical Curves; Importance of Sight Distances for Horizontal and Vertical Curves ; Combination of Vertical and Horizontal Curves – Grade Compensation

Unit III

Geometric Design of Intersections : Types of Intersections; Design Principles for Intersections; Design of At-grade Intersections – Channelization, Objectives; Traffic Islands and Design standards; Rotary Intersection – Concept, Advantages and Disadvantages; Grade separated Interchanges – Types, warrants and Design standards.

Unit IV

Miscellaneous Elements: Requirements of Pedestrians; Pedestrian facilities on Urban Roads; Cycle Tracks – Guidelines and Design standards; Bus bays –Types and Guide lines; Design of On-street and Off street Parking facilities – Guidelines for lay out Design.; Design of Ramp

Unit V

Airport and Railway Infrastructure Design – Runway orientation, Site selection, Wind rose analysis Geometric design standards for runways, taxiways, aprons , Airport capacity analysis, Terminal design; GEOMETRIC DESIGN OF RAILWAY TRACK: Gradients- Grade Compensation- Cant and Negative Superelevation- Cant Deficiency – Degree of Curve – Crossings and Turn outs .

TEXT BOOKS:

1. Principles and Practice of Highway Engineering, L.R.Kadiyali and N.B.Lal, Khanna
2. Traffic Engineering and Transportation Planning, L.R.Kadiyali, Khanna Publications
3. Highway Engineering, C.E.G.Justo and S.K.Khanna, Nem Chand and Brothers.
4. IRC Codes for Signs, Markings and Mixed Traffic Control in Urban Areas.

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

I Year – I Sem. M.Tech. (Highway Engineering)

L	T/P/D	C
3	0	3

(R11HIG2102)HIGHWAY PROJECT FORMULATION & ECONOMICS

Unit I

Project Formulation: Requirements in project formulation, Criteria fixation, Components of project, Non-monetary and monetary Criteria in formulation of project, Decision making Criteria input in Project formulation. Preparation of DPR - Guidelines , Transport Projects and development of cash flow diagrams, Cost and benefit components, Discounting criteria, Preparation of Project, Highway Planning, Traffic infrastructure, Project formulation, Road Network project development. Need for Economic Evaluation; Principles of economic evaluation; Welfare economics; Social costs, Vest change, Rate of return

Unit II

Road user costs: Value of Travel time Savings - Economic concept of evaluation of travel time savings; Issues connected with evaluation of travel time savings. Vehicle operating costs- Components of VOC, Road User Cost study in India; Accident costs; Methodologies for economic evaluation of an accident ; Factors involved, Basic methods of economic analysis

Unit III

Basic methods of economic analysis; Equivalent Uniform Annual Cost Method; Present worth of cost method; Equivalent uniform annual net return method; Net present value method; Benefit cost ratio method; Rate of Return Method. Applications of these methods to highway projects.

Unit IV

Project appraisal by shadow pricing with case studies.; Toll system analysis , Financial analysis ; Budgeting

Unit V

Environmental impact assessment: Basic Concepts, Objectives, Transportation Related Environmental Impacts – Vehicular Impacts – Safety and Capacity Impacts – Roadway Impacts – Construction Impacts, Environmental Impact Assessment – Environmental Impact Statement, Environment Audit, Typical case studies

TEXT BOOKS:

1. Transportation Engineering Economics - Heggie. I. G.; Mc Graw Hill Publishers.
2. Economic Analysis for Highways - Winfrey.R; International TextBook Company.
3. Traffic Engineering and Transport Planning - L.R Kadiyali, Khanna Publishers.

REFERENCE BOOKS

1. Road User Cost Study, CRR
2. Road Project Appraisal, for Developing Countries, J.W.Dickey ,John Wiley & Sons.

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I Year – I Sem. M.Tech. (Highway Engineering)

L	T/P/D	C
3	0	3

(R11HIG2103)TRAFFIC ENGINEERING

Unit I

Traffic Characteristics, road user characteristics – human factors including reaction time and vehicular characteristics affecting road design and traffic flow Traffic studies - data collection, analysis and interpretation of results of classified traffic volume, spot speed, speed and delay, origin and destination. Accident characteristics, causes, studies, investigations and analysis of individual accidents, statistical analysis, measures to improve road safety. Problems on above

Unit II

Traffic flow characteristics, traffic flow variables, speed – flow – density relationship, PCU values, level of service, factors influencing roadway capacity, capacity of roads at various levels of service, capacity of intersections.

Unit III

Traffic regulations and control - Regulation on vehicles, drivers and traffic flow, Traffic control devices – Types & objectives of markings, signs, signals and islands, delineators. Design of signalized intersections including signal timings as per IRC guidelines. Signal system, use of software Problems.

Unit IV

Design of other types of intersections at grade such as intersections with markings, channelized intersections and traffic rotary. Traffic design of grade separated intersections and interchange facilities.

Unit V

Design of on-street and off-street parking facilities, pedestrian facilities, bus bays, safety devices Design features of expressways and different types of Urban Roads

TEXT BOOKS

1. Kadiyali L.R. “Traffic Engineering and Transportation Planning”-Khanna Publication, New Delhi
2. Salter RJ and Hounsell NB, “Highway, Traffic Analysis and Design”- Macmillan Press Ltd., London.
3. Matson T M, Smith W S , Hurd F W, “ Traffic Engineering, Mc graw Hill Book Co, NY , USA.
4. Drew D R ,” Traffic Flow Theory and Control”, McGraw Hill Book Co, NY, USA.
5. Wohl and Martin, “Traffic System Analysis of Engineers and Planners”-Mcgraw Hill Book Co, New York, USA.

REFERENCE BOOKS

1. Pignataro , “ Traffic Engineering”, John wiley & sons.
2. Nicholas J Garber, Lester A Hoel, “Traffic & Highway Engineering”- Third edition, Bill Stenquist.
3. IRC: SP:41-1994, IRC SP:31-1992, IRC 43-1994, Indian Roads Congress
4. MoRTH “Type Designs for Intersections on National Highways”-Indian Roads Congress
5. MORTH “Manual for Road Safety in Road Design”-Indian Roads Congress
6. IRC3-1983,9-1972,62-1976,64-1990,65-1976,66-1976,67-2001,69-1977,70-1977,73-1980,79-1981,80-1981,86-1983,92-1985,93-1985,99-1988,102-1988,103-1988,106-1990,110-1996 Indian Roads Congress
7. Khanna and Justo, “Highway Engineering”- Nem Chand and Bros., Roorkee

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VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

I Year – I Sem. M.Tech. (Highway Engineering)

L	T/P/D	C
3	0	3

(R11HIG2104)PAVEMENT ANALYSIS DESIGN

Unit I

Road Pavements and pavement layers - types, functions, choice Factors affecting design and performance of flexible and rigid pavements – Pavement design factors, loads – axle load distribution, ESWL, EWL,VDF due to varying loads and CSA , Subgrade support - CBR and plate bearing tests, Resilient Modulus, fatigue tests, permanent deformation Pavement material Characteristics, climatic, drainage and environmental factors, their effects and evaluation.

Unit II

Stresses and Deflection / strain in flexible pavements: Application of elastic theory, stresses, deflections / strains in single, two and three layer system, Applications in pavement design. Problems .

Unit III

Flexible pavement design: Empirical, semi empirical and theoretical design approaches, principle, advantages and application. Design steps by CBR method as per IRC, outline of other common design methods such as AASHTO and Asphalt Institute methods, Problems.

Unit IV

Rigid pavement design: General design principle, Stresses in rigid pavements, stresses due to wheel loads and temperature variations, design of cement concrete pavements (joints and slab thickness) as per IRC guidelines. Design features of CRCP, SFRC and ICBP, Problems.

Unit V

Design of Airfields – Introduction to Runways, characteristics Design of airfields, Federal aviation authority, International Civil Aviation organization, taxiways design, lighting & marking Factors affecting design and performance of airport pavements.

TEXT BOOKS:

1. Yoder and Witczak, “Principles of Pavement Design”- John Wiley and sons Inc(second edition) 1975
2. YC Yang, “Design of functional Pavements”- Mc Graw Hill Book Co.
3. Huang, “Pavement Analysis”- Elsevier Publications
4. David Croney, Paul Croney, “Design & Performance of Road Pavements”- Mc Graw hill Book Co.

REFERENCE BOOKS

1. W.Ronald Hudson, Ralph Haas and Zeniswki “Modern Pavement Management”- Mc Graw Hill and Co
2. IRC 37-2001, IRC 81-1997, IRC 58 – 2002, IRC 59 – 1976, IRC 101-1988.

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I Year – I Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
Elective I	3	0	3

(R11HIG2105)APPLIED STATISTICS

Unit I

Introduction to Sampling Techniques and Statistical Distributions: Frequency distribution; Mean; Standard deviation; Standard error, Skewness; Kurtosis; Definitions and Applications; Simple random sampling; Stratified sampling; Systematic sampling; Sample Size determination; Applications in Traffic Engineering ; Statistical Distributions: Binomial, Poisson, Exponential and Normal distributions; Fitting of distributions; Mean and variance; Chi-square test of goodness-of-fit; Chi-square distribution; Students T-distribution; Snedectors, F-Distribution. Applications in Traffic Engineering.

Unit II

Probability: Laws of Probability; Conditional probability and Independent events; Laws of expectation.; Theorem of total probability and Baye's theorem.

Unit III

Regression and Correlation:
Linear regression and correlation; Multiple correlation; Multiple correlation coefficient; Standard error of estimate; Curvilinear regression models; Applications in Transportation Engineering.

Unit IV

Multivariate data analysis: Types of data; Basic vectors and matrices, Dispersion, Variance and covariance ,Analysis of Variance; Correlation matrices; Principal component analysis, Time series analysis

Unit V

Tests of Significance & Confidence Interval : Large sample and small sample tests; Tests for single mean, Means of two samples, Proportions, two variances, two observed correlation coefficients, Applications. Intervals for mean, variance and regression coefficients; Applications in Traffic Engineering problems.

Text Books

1. Basic Statistics - Simpson and Kafks; Oxford and IBH Calcutta, 1969.
2. Fundamentals of Mathematical Statistics – Gupta, S.C and Kapoor, K.V.Sultanchand.
3. Multivariate Data Analysis –Cootey W.W & Cohens P.R;John Wiley & Sons.

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I Year – I Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
Elective I	3	0	3

(R11HIG2106)PROJECT MANAGEMENT

Unit I

Introduction to Project Management: A systems Approach, Systems Theory and Concepts, Organization, Management Functions, Overview of Management Objectives, Tools and Techniques, Project Management – Processes and Organizational Structures – Team Management – Project Manager as a Team Leader – Leadership Qualities, PMIS

Unit II

Construction Cost and Value Engineering: Types of Estimates, Implementation of Cost Controls, Project Cost Forecasting, Cost Optimisation and Resources Planning - Value Engineering, Techniques for Project Selection, Break-Even Analysis, Cost Modelling, Energy Modelling, Life Cycle Cost Approach.

Unit III

Contract Management: Tendering and Contracting, Laws of Contracts, subcontracts, Potential Problems, Post Contract Problems, Documents, Conditions, Arbitration, Special Features of International Contracts. ; Human Resource Management: Man Power Planning – Training – Motivation – Industrial Relations – Welfare Measures – MIS – Components and Structure – Personal Management; Resource Management and Inventory: Basic concepts, labour requirements & productivity, non-productive activities, site productivity, equipment and material management, inventory control

Unit IV

Quality Management and Safety in Construction Industry: Quality control by statistical methods, sampling plan, control charts, ISO 14000, Safety Measures, Safety Programmes, Safety Awareness and Implementation of Safety Plan – Compensation; Construction Management Practices: Implementation of Procedures and Practices – International Experiences – Case Studies – Examples

Unit V

Project Scheduling and Analysis Methods: CPM, PERT, Linear programming, queuing concept, simulation, bidding models, game theory.

TEXT BOOKS:

1. Herold Kerzner - Project Management - A systems approach to Planning, Scheduling and Controlling. CBS Publishers and Distributors.
2. K.Waker A Teraih and Jose M.Grevarn; Fundamentals of Construction Management and Organisations.
3. Anghel Patterson - Construction Cost Engineering Handbook - Marcel Dekken Inc.
4. Dell Isola - Value Engineering in Construction Industry, Van Nostrand Reinhold Co.,

REFERENCES BOOKS

1. Choudhary, S. Project Management, Tata McGraw Hill Publishing Co., Ltd.,
2. Raina UK, Construction management Practices, Tata Mc Grawhill Publishing Company Ltd.
3. Sengupta B and Guha H, Construction Management and Planning, Tata McGraw-Hill Publishing Company Limited, New Delhi.

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

I Year – I Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
Elective I	3	0	3

(R11HIG2107)PRINCIPLES OF BRIDGE ENGINEERING

Unit I

Investigations and Planning: Investigations for culverts and minor bridges, Investigations for major bridges - topography, catchment, hydrology, geotechnical aspects, construction resources - design flood discharge - methods, linear waterway. choice of foundation for piers and abutments - types - cost ratio - clearance - choice of foundation - open, pile, well, block foundations - relative suitability. Setting out for piers and abutments for minor and major bridges. classification of culverts and bridges - components of bridge structures - loading standards - railway and road loading standards.

Unit II

Foundations I : Open foundations - excavation under G W T., baling out, cofferdams - floating caisson process - individual footings - raft footings - design considerations. pile foundations - types - load tests - strength - lateral resistance - construction of driven and cast-in-site piles - design considerations. Foundations II: Well foundation - types - caissons - design of wells - well sinking - open sinking and pneumatic sinking - materials for staining - concrete in staining - bottom plug, sand filling and well cap

Unit III

Piers, Abutments, Superstructure: Piers and abutments - function, aesthetics, materials; wing walls - construction aspects. Superstructure - types - choice of materials - design principles, considerations and criteria of pipe culverts, slab culvert, box culvert, causeways. Rc Bridges - Design Principles: Design of T beam and slab bridge - design principles of rc balanced cantilever bridge and articulation. Design concepts of rigid frame bridges - thumb rule design of masonry arch bridges - design of bowstring girder bridge and components.

Unit IV

Elements of Prestressed (Post Tensioned and Pretensioned) Concrete Bridge Design: Size, prestress force, eccentricity, design of cables, end blocks. Features and Design Consideration Of Bridges: Suspension bridges, cable stayed bridges and their components; bearings - types - design of rocker and roller bearings.

Unit V

Construction And Maintenance: Bridge superstructure construction - supports and centering for RC bridges - erection of precast RC girders and steel girder bridges - maintenance of bridges, strengthening of masonry arch bridges.

TEXT BOOKS

1. Victor J, "Essentials of Bridge Engineering", Oxford and IBH Publishing Co., New Delhi, 1999.
2. Krishna Raju N, "Design of Bridges", Oxford and IBH Publishing Co., New Delhi, 1998.
3. Bakht B and Jaeger L G, "Bridge Deck analysis simplified", McGraw Hill book company, Singapore, 1987
4. Ponnuswamy S, " Bridge Engineering", Tata McGraw Hill Publishing Co., New Delhi, 1986.
5. IS and IRC Codes

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I Year – I Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
Elective II	3	0	3

(R11HIG2108) RAIL ROAD ENGINEERING

Unit I

Introduction: Important development of Indian Railways, organization of Indian Railway, Track, Loco, Traction revolution for traffic growth on Indian Railways.

Unit II

Track & Track Stresses: Permanent way, Track standards & structure, Track Modulus, Forces on the Track, loads, Hammer blow effect Bending Stresses in rail, stresses in Sleeper, Ballast, coning & Tilting of rails, Type of rails, Defect in rails, Rail failure, welding, methods, ultrasonic testing of thermit welding joints, Fastening of rails, fish plates, spikes, bearing plates, Pandrol clips, new type of elastic fastening with S.T.sleeper, Rubber pads.

Unit III

Formation, Sleeper & Ballast: Functions of formation, profile of Banks & cuttings, Track drainage, failure of bank & remedial measures, soil stabilization & Geo-textiles methods, sleeper types, sleeper density, functions & requirement and Ballast types. Point & Crossing & Turnouts: modern trend in design, problems.

Unit IV

Geometric Design of Track: Radius, degree of curve, super elevation, gradients, speed calculation, safe speed, equilibrium speed, permissible speed, cant, cant deficiency, negative cant, Transition curve & its design, Types, shift, laying of T.C., vertical curve & its design, problems.

Unit V

Signal & interlocking: Types of Signal, details of electrical signaling system, track circuits, Absolute block system, Automatic block system, interlocking & methods, Modern signaling techniques, Route relay interlocking, CTC systems. Metropolitan Railways: Travel pattern, problems, Different forms of urban Transport, Trolley buses, surface railways, underground railways, elevated railways, mono rail, tube railways.

TEXT BOOKS:

1. Saxena & Arora.; “Railway Engineering” Dhanpat Rai. Delhi.2000.
2. Ronald.A.Inglis; “An Introduction to Railway Engineering” Chapman & Hall Ltd. London.1995.
3. W.W.Hay. Railway Engineering Chapman & Hall Ltd.London.1995.
4. Mundrey. J.S. Track Modernization.2000.
5. Manual on Signaling & Interlocking by Indian Railway board.1998

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I Year – I Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
Elective II	3	0	3

(R11HIG2109) CONCRETE TECHNOLOGY

Unit I

Cement and Admixtures: Portland cement - chemical composition – Bogue's compounds - hydration - structure of hydrated cement - mechanical strength of cement gel - water held in hydrated cement paste - heat of hydration of cement - influence of compound composition on properties of cement - different types of cements. Admixtures: Classification – Mineral and chemical admixtures - Classification of mineral admixtures – properties – dosage - uses – Chemical admixtures – classification – properties – uses – High range water reducing agents – effect of dosage – multiple dosage of admixtures and their effects – effects of admixtures in RMC.

Unit II

Aggregates: Classifications of aggregates - particle shape and texture - bond, strength and other mechanical properties of aggregate - specific gravity, bulk density, porosity, absorption and moisture content of aggregate - bulking of sand - deleterious substance in aggregate - soundness of aggregate - alkali-aggregate reaction - thermal properties - sieve analysis - fineness modulus - grading curves - grading of fine and coarse aggregates - gap graded aggregate - maximum aggregate size – combined a grading – BIS grading.

Unit III

Fresh Concrete and Hardened Concrete: workability - factors affecting workability - measurement of workability by different tests - effect of time and temperature on workability - segregation and bleeding - Mixing of concrete - different types of mixing – vibration of concrete – revibration – setting times of fresh concrete – steps in manufacture of concrete – quality of mixing water. Hardened Concrete: water/cement ratio - Abram's law – Gel space ratio Maturity concept - effective water in mix - nature of strength of concrete - strength in tension and compression - Griffith's hypothesis - autogenous healing - curing of concrete - influence of temperature on strength - steam curing - testing of hardened concrete – relation between compressive and tensile strength - factors affecting strength - non-destructive testing methods. Durability of concrete - codal provisions.

Unit IV

Elasticity, Shrinkage and Creep: Modulus of elasticity – static and dynamic modulus of elasticity - Poisson's ratio - early volume changes - swelling - shrinkage - mechanism of shrinkage - factors affecting shrinkage - differential shrinkage - moisture movement - creep of concrete - factors influencing creep - relation between creep and time - nature of creep - effects of creep in structural concrete – Codal provisions – Rheology of creep.

Unit V

Concrete Mix Design and Special Concrete – factors in the choice of concrete mix proportions – statistical quality control – Acceptance criteria as per IS 456-2000 – various mix design methods for normal concrete – BIS method – Road note no.4 method, ACI method – High strength concrete mix design – durability aspects in concrete mix design as per IS 456-2000. Special Concrete: Light weight concrete – Light weight aggregates – Light weight concrete mix design – Cellular concrete – Fiber reinforced concrete – Different types of fibres – Factors affecting properties of F.R.C. – Applications – Polymer concrete – Types of polymer concrete – Properties of polymer concrete – Applications – High Performance Concrete -Self Compacting concrete – smart concrete.

TEXT BOOKS:

1. Properties of Concrete by A.M.Neville, ELBS publications.
2. Concrete Technology by M.S.Shetty, S.Chand & Co.

REFERENCE BOOKS:

1. Special Structural concretes by Rajat Siddique, Galgotia Publications.
2. Design of Concrete Mixes by N.Krishna Raju, CBS Publications.
3. Concrete: Micro Structure by P.K.Mehta, ICI, Chennai.

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I Year – I Sem. M. Tech (Highway Engineering)	L	T/P/D	C
Elective II	3	0	3

(R11HIG2110)ENVIRONMENTAL IMPACT ASSESSMENT

Unit I

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 II

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 III

Environmental issues in water resource development - Land use - Soil erosion and their short and long term effects - Disturbance and long term impacts - Changes in quantity and quality of flow –Sedimentation – Environmental impact assessment of water resource development structures – Case studies, Water Quality Impact Assessment - Attributes, Water Quality Impact Assessment of Water

Unit IV

Resources Projects, Data Requirements of Water Quality Impact Assessment for Dams, Impacts of Damson Environment, Case Studies. Environmental Issues in Industrial Development: On-site and Off-site impacts during various stages of industrial development, Long term climatic changes, Green house effect, Industrial effluents and their impact on natural cycle, Environmental impact of Highways, Mining and Energy development

Unit V

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

TEXT 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.
3. Co., New York
4. UNESCO, (1987), "Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development", UNESCO/UNEP, Paris

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I Year – I Sem. M.Tech. (Highway Engineering)

L T/P/D C

Lab I

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(R11HIG2201)HIGHWAY ENGINEERING LAB - I

Cycle I

Tests on Pavement Materials

Aggregates: Gradation- Routhfutch Method- Shape tests-Aggregate Impact Test- Los Angeles Abrasion Test – Compressive strength of Aggregates- Specific Gravity Test and Water Absorption Test, bulrage of sand

Bitumen: Penetration Test-Ductility Test- Softening point Test-Flash and Fire Point Test- Viscosity test- Stripping Test- Marshall Stability Mix Design-Analysis, Binder content determination (Pavement Core Drilling machine)

Cycle II

Soil: Basic Tests-Gradation-dry and wet-Hydrometer Analysis- CBR Test, Plate load test. Soil stabilization.

Mix Design

WMM, GSB

Note: All tests are as per IS, ASTM, AASHTO, TRL, IRC, BS procedures / specifications and guidelines

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I Year – II Sem. M.Tech. (Highway Engineering)

L	T/P/D	C
3	0	3

(R11HIG2111)PAVEMENT MANAGEMENT SYSTEMS

Unit I

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 II

Pavement Performance: Serviceability Concepts- roughness- Roughness Components-Equipment-IRI -modeling techniques, structural condition deterioration models, mechanistic and empirical models, HDM and other models, comparison of different deterioration models. Functional Evaluation: Functional and Structural deterioration models, unevenness prediction models and other models, comparison. Case studies. Equipments

Unit III

Evaluation of Pavement Structural capacity:- Basics- NDT and Analysis— Condition Surveys- Distress-Destructive Structural Analysis- Application in Network and Project Levels

Unit IV

Design Alternatives and Selection: design objectives and constraints, basic structural response models, physical design inputs, alternate pavement design strategies and economic evaluation, life cycle costing, analysis of alternate pavement strategies based on distress and performance, case studies. Equipments

Unit V

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.

TEXT BOOKS

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
3. Proceedings of North American Conference on Managing Pavement
4. Proceedings of International Conference on Structural Design of Asphalt Pavements NCHRP, TRR and TRB Special Reports

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I Year – II Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
	3	0	3

(R11HIG2112)URBAN TRANSPORT PLANNING

Unit I

Travel Demand Concept Demand function: Independent variables: Travel attributes; Assumptions in Travel demand estimation; Sequential, Sequential recursive and Simultaneous process.

Unit II

Data Collection and Inventories; Study area definition; Zoning principles; Travel data collection - Road side interview, Home interview; IPT surveys; Sampling techniques; Expansion factors; Use of Secondary sources in data collection.

Unit III

Travel Demand Estimation; Four step Travel Demand Forecasting approach; Trip generation Analysis; Zonal models Category analysis; Household models; Trip attraction of work centers.

Unit IV

Trip Distribution; Mode Factor methods; Gravity model; opportunity model. Mode Split Analysis; Mode choice behavior; computing modes; Diversion curves; Probabilistic approaches.

Unit V

Traffic Assignment Traffic network and coding; Minimum path trees; All or nothing assignment; Capacity restraint assignment; Corridor Identification; Plan preparation and Evaluation; Deficiency analysis.

TEXT BOOKS

1. Introduction to Transportation Planning - M.J.Bruton; Hutchinson of London Ltd.
2. Introduction to Urban System Planning - B.G.Hutchinson; Mc Gra Hill.

REFERENCES BOOKS

1. G.E. Gray and CA Hoel: Public Transport Planning Operation and Management, Prentice Hall
2. White PR, Planning for Public Transport, UCL Press Ltd.

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I Year – II Sem. M.Tech. (Highway Engineering)

L	T/P/D	C
3	0	3

(R11HIG2113)HIGHWAY CONSTRUCTION & QUALITY CONTROL

Unit I

Components of road and pavement structure including subgrade, drainage system, functions, requirements and sequence of construction operations Plants and equipment for production of materials - crushers, mixers, bituminous mixing plants, cement concrete mixers – various types, advantages and choice.

Unit II

Drainage – Assessment of drainage requirements for the road and design of various components, drainage materials, Construction of surface and subsurface drainage system and design of filter materials for roads. Drainage for urban roads.

Unit III

Road construction equipment – different types of excavators, graders, soil compactors / rollers, pavers and other equipment for construction of different pavement layers – their uses and choice Problem on equipment usage charges; Pre-construction surveys and marking on ground - Specifications and steps for the construction of road formation in embankment and cut, construction steps for granular sub-base, quality control tests.

Unit IV

Different types of granular base course – WMM, CRM, WBM; specifications, construction method and quality control tests. Different types of bituminous layers for binder and surface courses; their specifications (as per IRC and MORTH); construction method and quality control tests. Different types of sub-base and base course for cement concrete (CC) pavement and construction method. Construction of cement concrete (PQC) pavements joints quality control during construction. Construction details of interlocking concrete block pavements

Unit V

Principle of construction planning, application of CPM and PERT(Problems not included) Road maintenance works – day to day and periodic maintenance works of various components of road works and road furniture. Preparation of existing pavement – patching, profile correction, Special measures to deal with reflection cracks in pavement layers, slipperiness of surface, etc. Special problems in construction & maintenance of hill roads, land slide, causes, investigation, and preventive and remedial measures, protection of embankment and cut slopes.

TEXT BOOKS:

1. Peurifoy, R.L., and Clifford, JS “**Construction Planning Equipment and Method**”- McGraw Hill Book Co. Inc.
2. Sharma S.C., “**Construction Equipment and its Management**”- Khanna Publishers
3. Freddy L Roberts, Prithvi S Kandhal et al, “**Hot Mix Asphalt Materials, mixture design and construction**”- (2nd Edition), National Asphalt Pavement Association Research and Education Foundation, Maryland, USA

REFERENCE BOOKS

1. National Asphalt Pavement Association “**Hot Mix Asphalt Paving Hand book**”- 5100 Forbes Boulevard, Lanham, Maryland, USA
2. “**Hand Book on Cement Concrete Roads**”- Cement Manufacturers Association, New Delhi
3. MoRTH “**Specifications for Roads and Bridge Works**”- 2001, fourth revision, Indian Roads Congress
4. MoRTH “**Manual for Construction and Supervision of Bituminous Works**”- 2001, Indian Roads Congress
5. MoRTH “**Manual for Maintenance of Roads**”- 1989, Indian Roads Congress
6. IRC: 42-1994, IRC:15-2002, IRC SP :11-1988, , 55-2001, 57-2001,58-2001, IRC 19-1977, 27-1967, 29-1988, 34-1970, 36-1970,48-1972,61-1976, 63-1976, 68-1976, 81-1997,82-1982, 84-1983,93-1985, 94-1986, 95-1987, 98-1997, 105-1988.

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I Year – II Sem. M.Tech. (Highway Engineering)

L	T/P/D	C
3	0	3

(R11HIG2114)REMOTE SENSING & GPS

Unit I

Remote Sensing: Basic Principles – Introduction, Electromagnetic and its properties, interaction with Earth surface materials, recent developments in Remote sensing, Social and legal implications of Remote Sensing, status of Remote Sensing. Characteristics of imaging remote sensing instruments, satellite remote sensing system – a brief over view, other remote sensing satellites.

Unit II

Pre-Processing Of Remotely Sensed Data: Introduction, cosmetic operation; Geometric connection and registration, atmospheric correction. Image Transforms: Introduction, arithmetic operations, empirically based image transforms, Principal component analysis, multiple discriminate analysis etc.

Unit III

Enhancement Technique and Filtering Techniques: Introduction, human visual system, contrast enhancement; Pseudo color enhancement. Thematic information extraction, classification and accuracy assessment and change detection. Hyper spectral and radar sensors
Filtering Technique Classification Low-pass (smoothing filters) High pass (sharpening) filters, edge detection, frequency domain filters, geometrical basis, classification, unsupervised and supervised classification, classification accuracy. Rectification of digital land satellite imagery. Image enhancement, spectral and spatial filtering

Unit IV

Global Positioning Systems: Introduction, Elements of satellite surveying, e global positioning system, GPS satellites, Adjustment computations, GPS observables, GPS- space segment, Control segment, User segment, GPS satellite signals, Receivers; Static, Kinematic and Differential GPS .

Unit V

Applications of Remote sensing and GPS in Transportation Engineering : Intelligent Transport System, Urban Transport Planning, Accident Studies, Transport System Management, Road Network Planning

TEXT BOOKS:

1. GPS Satellite Surveys, Alfred Leick, Willey & Sons
2. Principles of Remote Sensing, Paul Jumani, ELBS, 1985.
3. Computer processing of remotely sensed Images an Introduction – Paul M.Mather, John Wiley & Sons 1989

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I Year – II Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
Elective III	3	0	3

(R11HIG2115)RURAL ROADS

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, Factors controlling alignment, Special considerations while aligning hill roads, Surveys, Detailed project report, Environmental issues

Unit II

Geometric Design: Introduction, Design speed, Basic principles of geometric design, Elements, Horizontal and vertical alignment, Alignment compatibility, Lateral and vertical clearances. 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

Unit III

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 Specifications and Construction: General, Selection of construction materials and methodology, Earthwork, Sub-base, Base course, Bituminous constructions, Semi-rigid pavement construction, Concrete pavements, Construction of special pavements, Equipment required for different operations.

Unit IV

Green 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. Quality Control in Construction: General, Pre-requisite, Specifications and codes of practice, Quality control tests during construction.

Unit V

Maintenance: General, Distresses/defects in pavements, Definitions of maintenance activities, Inventory of road and inspection, Types of maintenance, Classification of maintenance activities, Maintenance norms of maintenance cost.

TEXT BOOKS

1. IRC: SP 20-2002 ‘Rural Roads Manual’
2. IRC: SP 72-2007 ‘Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads’
3. IRC: SP 62-2004 ‘Guidelines for the Design and Construction of Cement Concrete Pavements for Rural Roads’
4. IRC ‘Specifications for Rural Roads’, MoRD, 2004
5. CRRRI ‘Various Reports on Use of Waste Materials’

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I Year – II Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
Elective III	3	0	3

(R11HIG2116)EVALUATION & STRENGTHENING OF PAVEMENTS

Unit I

Introduction: Highway and airport pavements, Types and component parts of pavements, their differences - Factors affecting design and performance of pavements.

Unit II

Stresses and Deflections in Flexible & Rigid Pavements: Stresses and deflections in homogeneous masses. Wheel load stresses, various factors in traffic wheel loads; ESWL and EWL factors. Pavement behavior under transient traffic loads; Factors affecting design and performance of pavements. Types of stresses and causes, factors influencing the stresses; general considerations in rigid pavement analysis, EWL, wheel load stresses, warping stresses, frictional stresses, combined stresses.

Unit III

Structural and functional requirements of flexible and rigid pavements; Pavement distress; different types of failures & its causes.

Unit IV

Evaluation of Surface Condition: Methods of measurement of skid resistance, unevenness, ruts and cracks. Pavement surface condition evaluation by physical measurements, by riding comfort and other methods; their applications.

Unit V

Evaluation of Pavement Structural Condition: Evaluation by non-destructive tests such as FWD, Benkelman Beam rebound deflection using BBD for flexible overlay design, Plate load test, wave propagation and other methods of load tests; evaluation by destructive test methods, and specimen testing.

TEXT BOOKS:

1. Yoder, E.J., and Witczak, 'Principles of Pavement Design', 2nd ed. John Wiley and Sons, 1975.
2. Yang, 'Design of Functional Pavements', McGraw Hill Book Co.
3. Khanna and Justo, 'Test Book of Highway Engineering' Nemchand brothers, Roorkee-2004.

REFERENCES BOOKS

1. Haas and Hudson 'Pavement Management System', McGraw Hill Book Co., New York.
2. HRB/TRB/IRC/International Conference on Structural Design of Asphalt Pavements.
3. Relevant IRC Publications
4. CMA Hand Book

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I Year – II Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
Elective III	3	0	3

(R11HIG2117)GROUND IMPROVEMENT TECHNIQUES

Unit I

Introduction to Ground Modification: Need and objectives of Ground Improvement, Classification of Ground Modification Techniques – suitability and feasibility, Emerging Trends in ground improvement.

Unit II

Mechanical and Hydraulic Modification: Methods of compaction, Shallow compaction, Deep compaction techniques – Vibro floatation, Blasting, Dynamic consolidation, pre-compression and compaction piles, Field compaction control.; Hydraulic Modification: Methods of dewatering – open sumps and ditches, Well-point system, Electro-osmosis, Vacuum dewatering wells; pre-loading without and with sand drains, strip drains and rope drains.

Unit III

Physical and Chemical modification: Stabilisation with admixtures like cement, lime, calcium chloride, fly ash and bitumen. Grouting: Categories of grouting, Art of grouting, Grout materials, Grouting techniques and control.

Unit IV

Reinforced Earth Technology: Concept of soil reinforcement, Reinforcing materials, Backfill criteria, Art of reinforced earth technology, Design and construction of reinforced earth structures.

Unit V

Soil Confinement Systems: Concept of confinement, Gabion walls, Crib walls, Sand bags, Evergreen systems and fabric formwork.; Miscellaneous Techniques: Design, Construction and applications of stone columns, lime columns.

TEXT BOOKS

1. Manfred R. Hanusmann - Engineering principles of ground modification - Mc. Graw-Hill pub. Co., New York.
2. Robert M. Koerner - Construction and Geotechnical methods in Foundation Engineering – Mc.Graw-Hill Pub. Co., New York.

REFERENCES

1. Winterkorn and Fang - Foundation Engineering Hand Book – Van Nostrand Reinhold Co., New York.
2. Aris C. Stamatopoulos & Panagiotis C. Kotzios – Soil Improvement by Preloading – John Wiley & Sons Inc. Canada.
3. P. Purushothama Rao – Ground Improvement Techniques – Laxmi Publications (P) Limited.

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I Year – II Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
Elective IV	3	0	3

(R11HIG2118)ADVANCED MODELING TECHNIQUES IN TRANSPORTATION ENGINEERING

UNIT-I

Introduction to Artificial Intelligence (AI), Significance of AI in Transportation Engineering and uses of AI for solution of Transportation Engineering problems. Comparison between statistical methods and various AI techniques.

UNIT-II

Fuzzy-logic: Introduction to Fuzzy-logic, merits and limitations of Fuzzy-logic, crisp sets: types and properties of crisp sets, Partition and covering, Fuzzy sets: membership function, basic fuzzy set operations, Fuzzy Relations, Fuzzy Logic applications in Transportation Engineering.

UNIT-III

Artificial Neural Networks (ANN): Introduction to Artificial Neural Networks (ANN), merits and limitations of ANN, Model of an Artificial Neuron, Neural Network Architectures: Single layer, Multi-layer feed-forward and Recurrent Networks, Learning methods (in Brief), Back-propagation Technique: Single and multi layer feed-forward Neural Network, Back propagation learning, Computations of Input, hidden and output layers, Calculation of error, Training of Neural Network, method of steepest descent and applications of Back-propagation Learning Algorithm in Transportation Engineering.

UNIT-IV

Genetic Algorithms (GA): Basic concepts of Genetic Algorithms (GA), Working Principle, types of Encoding, cross-over, Fitness function, Methods of Reproduction (in brief) and Applications of GA in Transportation Engineering.

UNIT-V

Expert Systems (ES): Introduction to Expert Systems (ES), basic concepts of ES and their Applications in Transportation Engineering.

Text Books

1. Neural Networks, Fuzzy Logic and genetic Algorithms, Synthesis and Applications, by S.
2. Rajasekaran and G. A. Vijayalakshmi Pai, Prentice hall of India Pvt. Ltd. New Delhi, 2003.
3. Fuzzy Logic With Engineering Applications, Timothy J. Ross, Mcgraw-Hill, 1995.
4. Artificial Intelligence in Business-Expert System, Harmon P and D. King, John Willey & Sons
5. Relevant IRC and TRB publications.

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I Year – II Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
Elective IV	3	0	3

(R11HIG2119)AIRPORT PLANNING & DESIGN

Unit I

Introduction: Growth of air transport, airport organization and associations, Classifications of airports airfield components, airport traffic zones and approach areas. Aircraft Characteristics Related to Airport Design: Components, size turning radius, speed, airport characteristics

Unit II

Capacity and Delay: Factors affecting capacity, Determination of runway capacity related to delay, gate capacity, Taxiway capacity. Airport planning, surveys and Design: Airport Site Selection, Runway length and width, sight distances, longitudinal and transverse grades, runway intersections, taxiways, clearances, aprons, numbering, holding apron, noise control, Problems.

Unit III

Planning and Design of the Terminal area: Operational concepts, space relationships and area requirements, vehicular traffic and parking at airports.

Unit IV

Airport Grading and Drainage: Grading of airport area, hydrology, design of drainage systems, construction methods, layout of surface drainage and subsurface drainage system, Problems.

Unit V

Air Traffic Control and Aids: Runways and taxiways markings, day and night landing aids, airport lighting, ILS and other associated aids.

TEXT BOOKS:

1. "Planning and Design of Airports" - Robert Horenjeff, 2nd edition, McGraw Hill Book Co.
2. "Airport Engineering"- G. Glushkov, V.Babkov, Mir Publuishers, Moscow.
3. "Airport Planning and Design"- Khanna, Arora and Jain, Nem Chand and Bros., Roorkee
4. Harry.R.Cedergern. "Drainage of Airfield pavements"- John Wiley and Sons.
5. Virender Kumar and Satish Chandra, "Airport Planning and Design"- Galotia Publication press.

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I Year – II Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
Elective IV	3	0	3

(R11HIG2120)GIS APPLICATION IN TRANSPORTATION ENGINEERING

Unit I

Introduction to GIS: Introduction, GIS over view, use of GIS in decision making, Data processing, Components of GIS, The GIS and the organization.

Unit II

Data Input and Output: Data input - Key board entry, Manual digitizing, Scanning, Remotely and sensed data, existing digital data, census related data sets, Data output - Hard copy and soft, copy devices. Data Quality: Components of data quality - Micro level, Macro level components, Sources of error, A note about data accuracy.

Unit III

Data Management: The data base approach, 3 classic data models, Nature of geographic data, Spatial data models, Databases for GIS. GIS Analysis and Functions: Organizing geographic data for analysis, Maintenance and analysis of the spatial data and non-spatial attribute data and its integration output formatting.

Unit IV

Implementing a GIS: Awareness, Developing system requirements, Evaluation of alternative systems, System justification and Development of an implementation plan, System acquisition and start up, Operation of the system. Application of GIS in Transportation Engineering – I; Intelligent information system for road accessibility study, GIS data base design for physical facility planning, Decision support systems for land use planning

Unit V

Application of GIS in Transportation Engineering – II: GIS applications in environment impact assessment, GIS based Highway alignment, GIS based road network planning, GIS based traffic congestion analysis and accident investigation.

TEXT BOOKS

1. GIS A Management, Perspenfi Stan Aronoff, WDL Publisher.
2. Principles of Remote Sensing, Paul Jumani, ELBS, 1985.
3. Computer processing of remotely sensed Images an Introduction – Paul M.Mather, John Wiley & Sons 1989

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I Year – II Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
Lab II	0	3	3

(R11HIG2202)HIGHWAY ENGINEERING LAB - II

Cycle I

Tests on Pavement Evaluation

Benkelman Beam tests, Roughness survey of roads, Pavement evaluation using DCP, MERLIN FWD

Cycle II

Bitumen & Bituminous Mix Performance

Brookfield Viscosity, APV, RTFO & Loss on Heating
Fatigue & Rutting for various bitumen mixes

Cycle III

Test on Aggregate mix
Stone Polishing Value
Skid Resistance

Note: All tests are as per IS, ASTM, AASHTO, TRL, IRC, BS procedures / specifications and guidelines