## SCHEME OF TEACHING AND EXAMINATION
### M.TECH. HIGHWAY TECHNOLOGY

### I SEMESTER – M.TECH.

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subject</th>
<th>Teaching Hours / Week</th>
<th>Duration of Exam in Hours</th>
<th>Marks for Total Marks</th>
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<td></td>
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<td>Lecture</td>
<td>Practical/Assignments/field work</td>
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<td>Exam</td>
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<tr>
<td>14 CHT11</td>
<td>Highway Materials</td>
<td>4</td>
<td>2</td>
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<tr>
<td>14 CHT12</td>
<td>Pavement Design and Analysis</td>
<td>4</td>
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<td>Highway Construction and Maintenance</td>
<td>4</td>
<td>2</td>
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<tr>
<td>14 CHT14</td>
<td>Traffic Engineering and Design</td>
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<td>14 CHT15x</td>
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<td>*Highway Materials Lab – 1</td>
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<td>14 CHT17</td>
<td>Seminar 1</td>
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### ELECTIVE - I
- 14 CHT151 - Road Projects
- 14 CHT152 – Soil Mechanics for Highway Engineering
- 14CHT 153 – Rural roads
- 14CHT154 – Road Construction equipment

*Highway Materials Lab – 1 – Soil, Aggregates & concrete Lab
## SCHEME OF TEACHING AND EXAMINATION
### M.TECH. HIGHWAY TECHNOLOGY

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subject</th>
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<tr>
<td>14 CHT21</td>
<td>Pavement Deterioration and Evaluation</td>
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<tr>
<td>14 CHT22</td>
<td>Highway planning and Economic Analysis</td>
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<td>14 CHT23</td>
<td>Road Construction Planning &amp; Management</td>
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<td>14 CHT26</td>
<td>*Highway Materials Lab – 2</td>
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<td>14 CHT27</td>
<td>Seminar 2</td>
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<td>* * Project Phase 1 (6 weeks duration)</td>
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### ELECTIVE – II
- 14 CHT251 – Applied statistics
- 14 CHT 252/ 14CIM252 – Ground Improvement Techniques
- 14CHT253 – Advanced Traffic Engineering
- 14CHT 254- Airport planning & Design
- *Highway Materials Lab – 2 – Lab on Bitumen & Bituminous Mix design, Field Tests

** Between II and III Sem after availing a vacation of two weeks
### SCHEME OF TEACHING AND EXAMINATION

#### M.TECH. HIGHWAY TECHNOLOGY

#### III SEMESTER – INTERNSHIP

<table>
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<th>Teaching Hours / Week</th>
<th>Duration of Exam in Hours</th>
<th>Marks for</th>
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<td>Lecture</td>
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<td>Exam</td>
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<td>14 CHT31</td>
<td>*Seminar / Presentation on Internship (After 8 weeks from the date of commencement)</td>
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<tr>
<td>14 CHT32</td>
<td>*Report on Internship</td>
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<td>14 CHT33</td>
<td>Internship - Evaluation &amp; Viva Voce</td>
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<td>Project phase-II (8 weeks duration)</td>
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# SCHEME OF TEACHING AND EXAMINATION

## M.TECH. HIGHWAY TECHNOLOGY

### IV SEMESTER – M.TECH.

CREDIT BASED

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<tr>
<td>14CHT41</td>
<td>Special problems in Road Construction</td>
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<td>Practical/Assignments/field work 2</td>
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<td>*project phase III (8 weeks)</td>
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<td>14 CHT44</td>
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<td>14 CHT45</td>
<td>Project work Evaluation (Phase I+II+III) - Report &amp;Viva voce</td>
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**TOTAL** 08 04 09 150 400 550 28

**GRAND TOTAL – 2400 MARKS; 94 CREDITS**

**ELECTIVE – III**

- 14CHT421 – Transportation Planning
- 14CHT422 – Bridge and Grade Separated Structures
- 14CHT 423 – Urban Public Transport
- 14CHT424-Construction quality and safety Management
Note:

1) Project Phase – I: 6 weeks duration shall be carried out between II and III Semesters. Candidates in consultation with the guides shall select a project topic, carry out literature review / visit to Industries to collect preliminary information/data for their project work. Evaluation shall be done during the second week of IV semester, Total Marks shall be 25.

2) Project Phase – II: 8 weeks duration. 3 days for project work in a week during III semester. Evaluation shall be done during the first two weeks of the IV Semester. The student shall present the progress of their project work. Total Marks shall be 25.

3) Project Phase III: 8 weeks duration. 3 days for project work in a week during IV semester. (3 days for course work+ 3 days for project work)


Marks of Evaluation of Project:

- The I.A. Marks of Project Phase – I & II shall be sent to the University along with Project Work report at the end of the Semester.

4) During the final viva, students have to submit all the reports.

5) The Project Valuation and Viva-Voce will be conducted by a committee consisting of the following:

a) Head of the Department (Chairman)
b) Guide
c) Two Examiners appointed by the university. (Out of two external examiners at least one should be present).
Basic road construction materials such as soils, aggregates, bitumen and Portland cement – types, source, functions, requirements, properties, tests and specifications for use in various components of road

Soil compaction for use in fill and subgrade of roads, compaction studies in laboratory and field, properties of compacted soils

Aggregates – Origin, classification, requirements, properties, Tests and specifications on road aggregates for flexible and rigid pavements. Importance of aggregate gradation problems on Rotchfutch and Critical sieve methods and Shape factor in mix design.

Bituminous binders – different types, properties and uses, physical tests on bitumen, Rheological and pavement performance related properties, Modified binders, ideal pavement binders, characteristics and applications in road construction, criteria for selection of different binders.

Bituminous mixes, types, requirements, properties, tests, Marshall Method of mix design, Criteria and super pave mix design, Additives & Modifiers in Bituminous mixes, problems on mix design.

Portland cement and cement concrete for use in road works – requirements, design of mix for CC pavement, use of additives, IRC specifications & Tests, joint filler and sealer materials.

Soil stabilization – principle, methods and tests, proportioning of materials and mix design, application of Rotchfutch method. Marginal and waste materials in road construction, their properties and scope in road construction. Use of Fly-ash in road embankment and cement concrete mixes, use of chemical stabilizers like RBI –81, soil fix etc in road construction.

Note: All Relevant Laboratory & Field Test will be conducted in Batches

REFERENCE BOOKS:
1. MoRTH ‘Specifications for Roads and Bridges Works’ - Indian Roads Congress
2. IS 73, revised 2006, IS 2720, IS 2386, IS 1201 to 1220, IS 8887- 1995, IS 217- 1986
7. “Guidelines for use of Geotextiles in Road Pavements and Associated works”- 2002, Indian Roads Congress
8. Khamma and Justo, “Highway Engineering”- Nem Chand and Bros., Roorkee
10. “Soil Mechanics for Road Engineers”- HMSO Publication

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
PAVEMENT DESIGN AND ANALYSIS

Subject Code: 14CHT12
IA Marks : 50
No. of Lecture Hrs/ Week : 04
Exam Hrs : 03
Total No. of Lecture Hrs. : 52
Exam Marks : 100

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. Factors affecting design and performance of airport pavements.

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.

Flexible pavement design: Emperical, 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.

Rigid pavement design: Determination of ESWL, EWL for dual and dual tandem wheel loads in Rigid pavements, 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.

REFERENCE BOOKS:
3. Huang, “Pavement Analysis”- Elsevier Publications
7. Khanna and Justo “Highway Engineering”- Nemchand & Bros, Roorkee

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
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.

**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 of urban roads, problems.

**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 subgrade (preparation of subgrade) in cutting, filling and at grade. Construction of subgrade in marshy areas and weak / expansive soils - logged - areas. Construction steps for granular sub-base, quality control tests.

**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. Special structural courses like stone matrix asphalt and mastic asphalt and construction of porous asphalt.

**Different types of sub-base and base course for cement concrete (CC) pavement and construction method.** Construction of cement concrete (PQC) pavements and joints, quality control during construction. Construction of special Cement concrete pavements like interlocking concrete block pavements (ICBP), Continuously reinforced cement concrete pavements (CRCP), Fibre reinforced cement concrete pavements (FRCP), white topping, Ultra thin white topping etc.

Construction details of

**General Aspects:** Quality assurance, statistical approach, quality system for road construction. Safety aspects during road construction and maintenance works. Installation of various traffic safety devices and information system

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. Preventive maintenance of road drainage system, pavements and other components of road. Preparation of existing pavement – patching, profile correction, Special measures to deal with reflection cracks in pavement layers, slipperiness of surface, etc. Requirements for rehabilitation, recycling and re-construction.

Special problems in construction & maintenance of hill roads, land slide, causes, investigation, and preventive and remedial measures, protection of embankment and cut slopes.

**REFERENCE BOOKS:**
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
5. “Hand Book on Cement Concrete Roads”- Cement Manufacturers Association, New Delhi

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
TRAFFIC ENGINEERING AND DESIGN

Subject Code: 14CHT14
IA Marks: 50
No. of Lecture Hrs/ Week: 04
Exam Hrs: 03
Total No. of Lecture Hrs.: 52
Exam Marks: 100

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. Sampling in traffic studies – sampling techniques, sampling theory, accuracy and sample size. Accident characteristics, causes, studies, investigations and analysis of individual accidents, statistical analysis, measures to improve road safety. Problems on above

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,

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.

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.

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

REFERENCE BOOKS:
9. MoRTH “Type Designs for Intersections on National Highways”-Indian Roads Congress
10. MORTH “Manual for Road Safety in Road Design”-Indian Roads Congress
12. Khanna and Justo, “Highway Engineering”- Nem Chand and Bros., Roorkee

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
Introduction: Various steps of preparation and execution of road projects. Investigations for preparation of project reports for new and upgradation of roads. Objects and scope of pre – feasibility, feasibility and detailed studies for project preparation. Typical HR structure for preparations and implementation of road projects

Topographic surveys and investigations for finalisation of horizontal alignment and vertical profile of roads, Application of GIS. Geometric Design elements, standards and specifications for road projects

Soil investigations for assessing the design details of road embankments and cuts, drainage requirements and foundation of cross drainage structures

Material surveys and investigations for availability and choice of basic and alternate materials for road construction and for soil stabilisation

Traffic studies – classified traffic volume, growth rate, projected traffic for assessing road way requirements, origin-destination characteristics and studies, Axle load / wheel load studies using weigh bridges and analysis of data for pavement design

Traffic forecast - traffic growth estimation from past trends, econometric models. Common methods of traffic forecast

Environmental and social impact studies and assessment relevant to road upgradation / new projects, Mitigation measures, Road safety audit

Collection of relevant data, analysis and interpretation for pre-feasibility and feasibility study reports of the proposed road project. Economic evaluation of different possible alternatives. Preparation of drawings and project reports. Use of software

Preparation of DPR design details, estimates, BOQ, drawings and detailed project report, use of software

Tendering process - Preparation of tender documents for different types of road projects, tender evaluation

REFERENCE BOOKS:
5. MoRTH “Specifications for Road Bridge Works”- 2001, fourth revision, Indian Roads Congress
7. MoRTH “Model Concession Agreement for Small Road Projects”-2000, Indian Roads Congress

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
Soil Mechanics for Highway Engineering

Introduction: Soil Mechanics applications to Highway Engg. Soil formations, Types, Regional Soil deposits of India, Index properties, their determination, importance, various soil classification systems, HRB classification, problems on these.

Soil Compaction: Introduction, Lab Tests, Factors affecting, Structure & Engg behavior of compacted cohesive soil, Field compaction specifications, Field compaction control, Different types of Equipments used for compaction, their choice.


Permeability of soil: Darcy’s Law, Validity, Soil-water system, Types, Determination of permeability, problems.

Site Investigation: Introduction, Planning exploration programmes, Methods, Samplers, SPT, Subsoil investigation Report, Geophysical methods.

Highway Drainage: Introduction, Importance, Surface drainage, Sub-surface drainage, methods. Design of subsurface drainage system, Road construction in water logged areas, Land slides – definition, classifies, factors producing.

Reinforced Earth structures Introduction, Components, Advantages, Types of stability – external, Internal, (No problems), Geo textiles – types, Functions, their uses in road embankments and railway works, other uses.

Reference books

6. IRC – Relevant Codes.
Planning of rural road network – general principle, guidelines laid down in recent 20-year plans and in PMGSY

Guidelines for alignment and geometric design of rural / low volume roads

Investigations and surveys, soil and material surveys, scope for use of alternate marginal / low cost / waste / stabilized local materials in rural road works

Design of different types of pavements for rural roads, choice of pavement type / pavement materials. Guidelines and specifications by IRC, NRRDA and MORD

Road drainage – study of requirements of surface and subsurface drainage, and cross drains, standard design of culverts and small bridges

Specifications and steps for the construction of different components of rural / low volume roads including pavement layers, quality control during construction

Construction using special techniques / materials – Gravel Roads, fly ash in fill and other layers, use of other waste materials. Soil stabilization methods – mechanical, soil cement, soil lime, soil-lime-pozzolana, soil-lime-cement stabilization

Maintenance of rural roads – shoulders, side and cross drains. Pavement distress, different types of failures and maintenance measures. Preventive maintenance works.

REFERENCE BOOKS:
2. IRC SP- 26 “Report Containing Recommendations of IRC Regional Workshops on Rural Road Development”-1984, Indian Roads Congress
5. MoRTH “Specifications for Road and Bridge Works”- 2001, fourth revision, Indian Roads Congress
6. MORD “Specification for Rural roads”
7. MORD “Standard data book for analysis of rates for rural roads”
8. CRRI “Low Volume Roads’ Central Road Research Institute”-New Delhi.

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
Introduction: Working principle, capacity, rate of production, applications, advantages and limitations of various types of construction equipment

Equipment for earthwork excavation, hauling and spreading: Dozers; power shovels, Scrapers, 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

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

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

Miscellaneous Equipment: Kerb casting equipment, road marking equipment, bitumen sprayers, water tankers

Equipment Management: Equipment planning, forecasting equipment requirement, maintenance, workshop, work study, Selection of Construction Equipment - task considerations, cost considerations, equipment acquisition options

REFERENCE BOOKS:
4. “Operation Manuals of various equipment manufacturers”.

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
Tests on soil
1. Grain size analysis - Wet sieve analysis
2. Liquid limit, plastic limit & Shrinkage limit
3. Compaction test
4. California bearing ratio test

Tests on aggregates
1. Shape tests - Elongation, Flakiness Index & Combined Index
2. Aggregate impact value test
3. Los angeles abrasion value test
4. Specific gravity & Water absorption test
5. Stripping value test

Tests on cement & concrete
1. Fineness
2. Std consistency & setting time of cement
3. Soundness
4. Compressive strength

Concrete
1. Concrete Mix design
2. Compressive Strength
3. Flexural strength

REFERENCES
1. Relevant IS and IRC codes
II Semester

**PAVEMENT DETERIORATION AND EVALUATION**

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**Structural and functional requirements of flexible and rigid pavements.** Distress and different types of failures in pavements. Functional and structural deterioration of flexible and rigid pavements, Deterioration models.

**Structural deterioration of pavements,** causes, effects, methods of treatment. Structural evaluation of flexible pavements by Rebound deflection method, Analysis of data, interpretation and applications, design of overlay. "Use of FWD and other methods for evaluation of flexible and rigid pavements and their application. Problems


**Discussion on choice of overlay type** and pavement materials over existing flexible and rigid pavements, with different degrees of distress.

**Evaluation of new pavement materials,** model studies, pavement testing Under controlled conditions, accelerated testing and evaluation methods.

**Test track studies.** Instrumentation for pavement testing.

**REFERENCE BOOKS:**

3. Per Ulitz *Pavement Analysis* - Elsevier Amsterdam.
5. HRB/TRB/IRC/ *International Conference on structural design of Asphalt pavements*.

**Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.**
HIGHWAY PLANNING AND ECONOMIC ANALYSIS

Subject Code : 14CHT22
IA Marks : 50
No. of Lecture Hrs/ Week : 04
Exam Hrs : 03
Total No. of Lecture Hrs. : 52
Exam Marks : 100

Highway Planning – Objects, need for highway planning, types of planning, planning surveys. Interpretation, Preparation of Master plans, NTP and NTPC in India. Traffic studies – Volume study, types of volume counts viz, key count, control counts, coverage counts etc. Estimation of future traffic by different approaches, speed studies, load meter study, 20 year road development plan including 1st and 2nd 20 year plan in brief and 3rd and 4th 20 year plan in detail. Land use planning. Land use development – models, problems on the above topics, Highway Planning in India.

Highway Engineering Economics, principle, supply and demand models, equilibrium, sensitivity of travel demand, Elasticities – types, models (Kraft demand model) consumer surplus cost – cost elasticity pricing and subsidy policies, rates of interest, Vehicle operation cost, direct and indirect benefits due to road improvement, Total transportation cost, fixed and variable costs. Road user cost studies in India.

Economic analysis, different methods, determination of annual cost, benefit cost ratio, IRR, FIRR, NPV. Sensitivity of economic analysis, Examples of economic analysis for different types of road improvement measures, pavement options, construction of bypasses and upgrading of intersections. Project priorities, methods of dealing with uncertainties.

Highway financing, various options for road and bridge projects, special cess, tolling, BOT, BOOT and other options. Economic and financial analysis of highway projects and use of computer software packages. Road investment decision packages.

REFERENCE BOOKS:
7. “Road User Cost Study in India”- Final Report, Central Road Research Institute, New Delhi, 1982.

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
Various types of highway development projects in progress in India and their scope. Factors to be considered in planning of new highway /expressway / bypass and up-gradation of existing roads.

**Planning of Road Projects** – project management framework, scope, project objectives, project environment, causes of project failure, project development process

**Resource planning** – human resources, project man power grouping, structuring site organisation, construction materials-classification of construction materials, materials usage, materials inventory, cost and budget

**Construction equipment and choice** - type, capacity and number, task considerations, cost considerations, engineering considerations, equipment acquisition options, optimum location of crushing and mixing plants, problems.

**Time planning** – project work breakdown, determining activities involved, assessment of duration, CPM / PERT network analysis, work scheduling, methods of work scheduling, factors affecting work scheduling, Problems.

**Planning Control System** – resource production, project cost, project time, codification and project management, information system, use of software

**REFERENCE BOOKS:**
4. IRC “A Manual for the Application of Critical Path Method to Highway Projects in India”
5. Nhao.org, pmgsy.nic.in websites

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
PAVEMENT MANAGEMENT SYSTEM

Subject Code: 14CHT24
IA Marks : 50
No. of Lecture Hrs/ Week : 04
Exam Hrs : 03
Total No. of Lecture Hrs. : 52
Exam Marks : 100

Introduction: components & principals of pavement management systems, pavement maintenance measures, planning investment, research management.

Pavement Performance Evaluation: general concepts, serviceability, pavement distress survey systems, performance evaluation

Pavement Performance Prediction: concepts, modeling techniques, structural condition deterioration models, mechanistic and empirical models, HDM and other models, comparison of different deterioration models. Functional condition deterioration models, unevenness prediction models and other models, comparison. Modeling in rehabilitation budget planning, case studies, Problems.

Ranking and Optimization Methodologies: Recent developments, sample size selection, economic optimization of pavement maintenance and rehabilitation.

Design alternatives and Selection: Design objectives and constraints, basic structural response models, physical design inputs, alternate pavement design strategies and economic evaluation, reliability concepts in pavement engineering, life cycles costing, analysis of alternate pavement strategies based on distress and performance, case studies and Problems.

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.

Implementation of Pavement Management Systems.

REFERENCE BOOKS:
5. NCHRP, TRR and TRB Special Reports.

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
ELECTIVE – II

APPLIED STATISTICS

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Introduction to statistical methods, scope aim and limitations, sample, attribute and types of data, sources and collection of data. Accuracy of data.

Representation and summarizing data. Frequency distribution, histogram and frequency curves. Ogive curve, Measure of central tendency – arithmetic mean, median and mode dispersion- range, standard deviation, variance and co-efficient of variation, skewness and kurtosis.


Sampling Techniques – objective, basics of sampling, advantages of sampling, sampling techniques, sampling distributions – sampling distribution of the sample mean, central limit theorem, chi square, t and F – distributions. Sampling error, sample size and design.

Statistical decisions – point estimation, properties of parameters, Testing of Hypothesis – Type II errors and I.


Chi-square test of goodness of fit, student’s t test, Confidence interval.

Curve fitting by the method of least squares, Linear correlation & regression, multiple linear regression. Analysis of variance

Use of soft wares in statistical analysis – MATLAB, MINITAB

REFERENCE BOOKS:


Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
GROUND IMPROVEMENT TECHNIQUES

Subject Code: 14CHT252
IA Marks: 50

No. of Lecture Hrs/ Week: 04
Exam Hrs: 03
Total No. of Lecture Hrs.: 52
Exam Marks: 100

Introduction - Need and objectives of ground improvement, classification of ground modification techniques, trends in ground improvement. Engineering properties of soft, weak and compressible deposits; Principles of treatment;

Methods of compaction, blasting, dynamic consolidation, pre-compression and compaction piles.

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.

Stabilisation with admixtures like cement, lime, calcium chloride, fly ash and bitumen and non traditional stabilizers. Methods of soil improvement-line stabilisation and injection; thermal, electrical and chemical methods;

Grouting - materials of grouting, grouting techniques and control.

Soil reinforcement - Reinforcing materials, concept of confinement, gabion walls,
Dynamic consolidation; Vibroflotation; Pre-consolidation with vertical drains; Granular piles; Soil nailing; Anchors; Grouting; Electro-osmosis; Soil freezing; Vacuum consolidation; Case histories

Improvement of Foundation Soils

(a) Improvement of granular soils: term used to describe degree of compactness – relative density, density ratio and degree of compaction;
Methods - Vibration at ground surface, factors influencing roller compaction; deep dynamic compaction, vibro-compaction impact at depth.
(b) Improvement of cohesive soils: preloading, or dewatering, methods of installing sand drains, drain wicks, electrical and thermal methods.
(c) Grouting: purpose, functions, types of grouts; soil bentonite - cement mix, cement mix, emulsions, solutions: grout injection methods.
(d) Geo-synthetics: types, functions, manufacturing of geo-textiles, Classification of geo-textiles.

Specific Applications: Bearing capacity improvement, reinforcement, retaining walls, embankment etc. testing of geo-synthetics, usage in India and case study.

References

Queuing theory and applications; vehicle arrivals, delays at intersections, Elements of simulation technique in traffic Engineering, Problems.


Road accidents, causes, scientific investigations and data collection. Analysis of individual accidents to arrive at causes; statistical methods of analysis of accident data, computer analysis. Road safety issues, various measures for road safety - engineering, educational and enforcement measures. Short term and long term measures. Road safety education and training. Economic evaluation of improvement measures by "before and after studies". Problems.

Traffic management techniques - Local area management. Transportation system management. Low cost measures. Various types of medium and long term traffic management measures and their uses. Evaluation of the effectiveness and benefits of different traffic management measures, Elements of area traffic control and Intelligent transportation systems.

Environmental issues – air and noise pollution due to road traffic, measurement, control of environmental deterioration. Management of environmental pollution due to road traffic.

REFERENCE BOOKS:
1. L.R Kadiyali, "Traffic Engineering & Transport Planning" - reprint 2004, khanna publishers

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
AIRPORT PLANNING AND DESIGN

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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

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.

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

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

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

REFERENCE BOOKS:
3. “Airport Planning and Design” - Khanna, Arora and Jain, Nem Chand and Bros., Roorkee

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
Tests on bitumen / polymer modified binders
1. Penetration test
2. Viscosity test
3. Specific gravity test
4. Flash and fire point test
5. Ductility and elastic recovery test
6. Softening point test and separation test
7. Tests on bitumen Emulsion & Cutback bitumen

Tests on bituminous mixes
1. Proportioning of materials by Rothfutch’s method and Mix design by Marshall Method.

Field Tests
Field density by sand replacement & Core cutter method
Bitumen Extraction, bitumen content and aggregate gradation
Pavement evaluation tests such as:
- Benkelman Beam deflection studies & analysis
- Measurement of Unevenness by Merlin & Bump integrator
- Calibration of Bump Integrator

REFERENCES
1. Relevant IS and IRC codes

Methods of strengthening weak foundation soil, acceleration of consolidation and settlement of compressible embankment foundation, vertical sand drains - application, design and construction method.


Use of special materials such as geo-synthetics for drainage and in pavement layers.

Special construction techniques such as reinforced earth retaining walls, Nailing Technique, Techniques of pavement construction using recycled materials – cold and hot mix recycling of bituminous materials, construction techniques of cell filled concrete pavements – design, economics and construction method, and its application.

Road construction on desert region and coastal areas, alternative methods, road construction on high altitudes, hilly and mountainous terrain.

REFERENCE BOOKS:
2. IRC-75 “Guidelines for the design of High embankments”- IRC, 1979.

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
Introduction: Characteristics of different modes of transportation; Principles of co-ordination and operation control, Elements in urban transit system

Transportation Planning Process: Factors to be considered; land use transportation planning; Systems approach.

Transport Surveys: Planning of different types of surveys and interpretation, travel demand; Traffic surveys for mass transit system planning.

Trip Generation and Distribution: Factors governing trip generation and attraction; Zonal models; Category analysis; Methods of trip distribution; Application of gravity model.

Modal Split and Assignment: Factors affecting modal split; Modal split in transport planning; principles of traffic assignment; Assignment techniques

Evaluation: Identification of corridor; Formulation of plans; Economic Evaluation.

Mass Transit Systems: capacity, Fleet planning and Scheduling.

REFERENCE BOOKS:
3. Institute of Traffic Engineers – “An Introduction to highway Transportation Engineering”, ITE, USA

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
Introduction to Bridges: Basic Elements of a Bridge.

Types of bridges and grade separated structures for highways, standard specifications for road bridges and grade separated structures to fulfill traffic and Structural Engineering requirements.

Bridge bearings, joints, approaches, construction and maintenance aspects.

Basic design approaches of RCC, PSC and steel bridges.

General Design Considerations for superstructure. Types of bridge, grade separated structures and their choices, IRC Class AA Tracked and Wheeled Loading Analysis, Problems.

Introduction to Construction specification and quality control for foundations and substructures of bridges and grade separated structures.

Concept of evaluation of existing bridge structures. Methods of rehabilitation and widening.

REFERENCE BOOKS:

Standard Data Book on Highway Technology issued by the University may be referred in the P.G Examination of VTU.
URBAN PUBLIC TRANSPORT

Subject Code : 14 CHT-423
IA Marks : 50
No. of Lecture Hrs/ Week : 04
Exam Hrs : 03
Total no. of Lecture Hrs. : 52
Exam Marks : 100

System and Technologies: Urban passenger transportation modes, transit classifications and definitions, theory of urban passenger transport modes, rail transit, bus transit, Metro and Mono Rail, Para transit and ride sharing, designing for pedestrians, trends in transit rider ship and use of different modes.

Comparing Alternatives: Comparing costs, comparative analysis, operational and technological characteristics of different rapid transit modes, evaluating rapid transit, Problems.

Planning: Transportation system management, system and service planning, financing public transportation, management of public transportation, public transportation marketing.

Transit System Evaluation: Definition of quantitative performance attributes, transit lane capacity, way capacity, station capacity, theoretical and practical capacities of major transit modes, quantification of performance, Problems.

Urban traffic: Classification of transportation systems, conventional transportation systems, non-conventional transportation systems, prototypes and tomorrow's solutions, analysis and interpretation of information on transportation systems, perspectives of future transportation.

REFERENCE BOOKS:

CONSTRUCTION QUALITY & SAFETY MANAGEMENT

Quality and concept of QM - Necessity for improving quality,, concept of quality control, quality assurance, quality management and total quality management , Total quality management concepts; ISO9000 documentation; QA/QC systems and organizations, Quality Audits; Problem solving techniques; Statistical Quality Control; Quality Function Deployment; Material Quality Assurance; Specifications and Tolerances.

Quality Planning - Quality policy, objectives and methods in construction industry - consumers satisfaction - , time of completion - statistical tolerance.

Codes and standards quality manuals - documents - contract and construction programming - inspection procedures - processes and products - total QA / QC programme and cost implication.

Managing Quality in various projects stages from concept to completion by building quality into design of structures, Inspection of incoming material and machinery In process quality inspections and tests.


Quality Assurance Department -and quality control responsibilities of the line organization, developing quality culture in the organization, training of people,


Safety Programmes - elements of safety programmes, job-site assessment, safety meetings, safety incentives, contractual obligations, safety in construction contracts

Safety in Design - safety culture - Safe Workers- Safety and First Line Supervisors - Safety and Middle Managers - Top Management Practices, Company Activities and Safety - Safety Personnel - Sub-contractual Obligation - Project Coordination and Safety Procedures - Workers Compensation , Safety issues; Injury accidents and their causes; Safety program components; Role of workers, Supervisors, Managers and Owners; Safety Procedures for various construction operations; Safety audits; Safety laws.

Safety Management - safety and first line supervisors, safety and middle managers, top management practices, safety audit, safety equipment planning and site preparation, safety system of storing construction materials Excavation - blasting-timbering-scaffolding- safe use of ladders- safety in welding. First- aid- Fire hazards and preventing methods-

References
6. IS, IRC, Other codes