SCHEME OF TEACHING AND EXAMINATION

M.TECH. HIGHWAY TECHNOLOGY

I SEMESTER – M.TECH. / PGD

Subject Code	Name of the Subject	Teaching Hours / Week		Duration of Exam in Hours	Marks for		Total Marks
		Lecture	Practical/ Assignments / field work		I.A	Exam	
10 CHT11	Highway Materials	4	2	3	50	100	150
10 CHT12	Pavement Design and Management	4	2	3	50	100	150
10 CHT13	Highway Construction and Maintenance	4	2	3	50	100	150
10 CHT14	Traffic Engineering and Design	4	2	3	50	100	150
10 CHT15x	**Elective – 1**	4	2	3	50	100	150
10 CHT16	Seminar		3		50	---	50
TOTAL		**20**	**13**	**15**	**300**	**500**	**800**

ELECTIVE - I

10 CHT151 - Road Projects

10 CHT152 – Soil Mechanics for Highway Engineering

I SEMESTER

HIGHWAY MATERIALS

Subject Code	: 10CHT11	IA Marks	: 50
No. of Lecture Hrs/ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

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, 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, 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, properties and scope in road construction. Use of Fly-ash in road embankment and cement concrete mixes

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
3. State of art, special report 3 – "**compaction of earthwork and subrade"**- IRC, HRB, 1999
4. 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. IRC: 51-1992, 63-1976, 74 –1979, 88-1984, "**Indian Roads Congress".**
6. IRC SP : 53 – 2002, IRC SP: 58 – 2000, "**Indian Roads Congress".**
7. **"Guidelines for use of Geotextiles in Road Pavements and Associated works"-** 2002, Indian Roads Congress
8. Khanna and Justo, "**Highway Engineering"-** Nem Chand and Bros., Roorkee
9. Khanna and Justo, "**Highway Materials Testing"-** Nem Chand and Bros., Roorkee.
10. **"Soil Mechanics for Road Engineers"-** HMSO Publication
11. **"Bituminous materials in Road Construction**"- HMSO Publication.
12. **Highway Hand Book by FAW, Publication from NUS, Singapore.**

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

PAVEMENT DESIGN AND MANAGEMENT

Subject Code	: 10CHT12	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: 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.

Pavement management system – Introduction to Pavement deterioration, objects and Principle of pavement management.

REFERENCE BOOKS:

1. Yoder and Witczak, "**Principles of Pavement Design"-** John Wiley and sons Inc(second edition) 1975
2. 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.
5. W.Ronald Hudson, Ralph Haas and Zeniswki "**Modern Pavement Management"-** Mc Graw Hill and Co
6. IRC 37-2001, IRC 81-1997, IRC 58 – 2002, IRC 59 – 1976, IRC 101-1988, Indian Roads Congress
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.

HIGHWAY CONSTRUCTION AND MAINTENANCE

Subject Code	: 10CHT13	IA Marks	: 50
No. of Lecture Hrs/ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

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 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.
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 details of interlocking concrete block pavements

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:

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
4. National Asphalt Pavement Association "**Hot Mix Asphalt Paving Hand book**"- 5100 Forbes Boulevard, Lanhm, Mary Land, USA
5. **"Hand Book on Cement Concrete Roads"-** Cement Manufacturers Association, New Delhi
6. MoRTH "**Specifications for Roads and Bridge Works**"- 2001,fourth revision, Indian Roads Congress
7. MoRTH "**Manual for Construction and Supervision of Bituminous Works**"- 2001, Indian Roads Congress
8. MoRTH "**Manual for Maintenance of Roads"-** 1989, Indian Roads Congress
9. 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.

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	: 10CHT14	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:

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

ELECTIVE – 1

ROAD PROJECTS

Subject Code	: 10CHT151	IA Marks	: 50
No. of Lecture Hrs/ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

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. Design standards and specification for relevant road geometrics.

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

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:

1. IRC: SP:19 - 2001, Manual for Survey, "**Investigation and Preparation of Road Projects"-** (first revision), Indian Roads Congress
2. IRC: SP: 30 - 1993, "**Manual on Economic Evaluation of Highway"-** Projects in India (first revision), Indian Roads Congress
3. IRC SP – 38,"**Manual for Road Investment Decision Model"-**1992, Indian Roads Congress
4. IRC : 9-1972, 35 – 1997,38-1988, 39-1986, 52-2001, 54-974, 62-1976, 64-1990, 66-1976, 67-2001, 69-1977, 73-1980, 79-1981, 80-1981, 86-1983, 98-1997, 99-1988, 103-1988, 104-1988, 110-1996
5. MoRTH "**Specifications for Road Bridge Works**"- 2001, fourth revision, Indian Roads Congress
6. MoRTH "**Standard and Bidding Document Procurement of Civil Works**"- Part I and II, 2000, 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

Subject Code	10 CHT 152	IA Marks	: 50
No. of Lecture Hrs/ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

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.

Shear strength of soil: Introduction, Importance, Measurements, shear strength of clay, Sand, Elastic properties of soil – Tangent, Secant modulus, Stress – Strain curves, Poisson's ratio, Shear Modulus.

Stability of slopes: Introduction, Types, Different methods of analysis of slopes for Øu+0 & C-Ø soil, Location of most critical circle, Earth dam slopes stability, Taylor's stability number. Effect of Earthquake Force, problems on above.

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

1. "Basic and Applied soil Mechanics", Gopal Ranjan, ASR Rao, New Age International Publishers.
2. "Soil Mechanics & Foundation Engg", Dr.B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Laxmi Publications (P) Ltd, 16th edition.

3. "Highway Engg", S.K. Khanna, C.E.G. Justo, 5th edition.

4. "Soil Mechanics & Foundation Engg" – K.R. Arora Standard Publishers Distributors.

5. "Soil Mechanics for road Engineers" – HMSO, London.

6. IRC – Relevant Codes.