VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017

M.Tech. Transportation Engineering

I SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credit
			Theory	Practical/Field Work/ Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16CTE11	Traffic Engineering - I	4	-	3	20	80	100	4
2	16CTE12	Pavement Materials	4	-	3	20	80	100	4
3	16CTE13	Applied Soil Mechanics and Ground Improvement Techniques	4	-	3	20	80	100	4
4	16CTE14	Urban Transport Planning	4	-	3	20	80	100	4
5	16CTE15X	Elective - 1	3	-	3	20	80	100	3
6	16CTEL16	Pavement Materials Testing Lab I		3	3	20	80	100	2
7	16CTE17	Seminar	-	3	-	100	-	100	1
TOTAL			**19**	**6**	**18**	**220**	**480**	**700**	**22**

Elective - 1	
16CTE151	Remote Sensing and GIS in Transport Planning
16CTE152	Railway Infrastructure Planning And Designing
16CTE153	Advanced Concrete Technology
16CTE154	Intelligent Transportation Systems

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SCHEME OF TEACHING AND EXAMINATION 2016-2017

M.Tech. Transportation Engineering

I I SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credit
			Theory	Practical/Field Work/ Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16CTE21	Traffic Engineering - II	4	-	3	20	80	100	4
2	16CTE22	Pavement Design and Analysis	4	-	3	20	80	100	4
3	16CTE23	Geometric Design of Transportation Facilities	4	-	3	20	80	100	4
4	16CTE24	Transportation Economics And Evaluation	4	-	3	20	80	100	4
5	16CTE25X	Elective-2	3	-	3	20	80	100	3
6	16CTEL26	Transportation Engineering Lab II		3	3	20	80	100	2
7	16CTE27	Seminar	-	3	-	100	-	100	1
TOTAL			**19**	**6**	**18**	**220**	**480**	**700**	**22**

Elective - 2	
16CTE251	Road Safety Management
16CTE252	Applied Statistics In Transportation Engineering
16CTE253	Environmental Impact Assessment of Transportation Projects
16CTE254	Optimization Techniques

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III SEMESTER: Internship

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credit
			Theory	Practical/Field Work/ Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16CTE31	Seminar / Presentation on Internship (After 8 weeks from the date of commencement)	-	-	-	25	-	25	20
2	16CTE32	Report on Internship	-	-	-	50	-	50	
3	16CTE33	Evaluation and Viva-Voce of Internship	-	-	-	-	75	75	
4	16CTE34	Evaluation of Project phase -1	-	-	-	25	-	25	1
TOTAL			**-**	**-**	**-**	**100**	**75**	**175**	**21**

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IV SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week		Examination				Credit
			Theory	Practical/Field Work/ Assignment	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	16CTE41	Pavement Construction Technology	4	-	3	20	80	100	4
2	16CTE42	Elective-3	3	-	3	20	80	100	3
3	16CTE43	Evaluation of Project phase -2	-	-	-	50	-	50	3
4	16CTE44	Evaluation of Project and Viva-Voce	-	-	3	-	100+100	200	10
TOTAL			**-**	**-**	**6**	**60**	**75**	**450**	**20**

Elective - 3	
16CTE421	Urban Mass Transport Systems
16CTE422	Pavement Evaluation And Management
16CTE423	Applications of Soft Computing Techniques
16CTE424	Rural Roads

Note:

1. Project Phase-1: 6-week duration shall be carried out between 2nd and 3rd Semester vacation. Candidates in consultation with the guide shall carry out literature survey/ visit industries to finalize the topic of Project.

2. Project Phase-2: 16-week duration during 4th semester**.** Evaluation shall be done by the committee constituted comprising of HOD as Chairman, Guide and senior faculty of the department.

3. **Project Evaluation**: Evaluation shall be taken up at the end of 4th semester. Project work evaluation and Viva-Voce examination shall conducted

4**. Project evaluation:**

a. Internal Examiner shall carry out the evaluation for 100 marks.

b. External Examiner shall carry out the evaluation for 100 marks.

c .The average of marks allotted by the internal and external examiner shall be the final marks of the project evaluation.

d. Viva-Voce examination of Project work shall be conducted jointly by Internal and External examiner for 100 marks.

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TRAFFIC ENGINEERING - 1

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER – I

Subject Code	16CTE11	IA Marks	20
Number of Lecture ours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

COURSE OBJECTIVES:

- Provide an insight on traffic and its components, factors affecting road traffic and the design of intersection
- Explain sampling of data, analysis and interpretation of data in conducting various surveys
- Explain traffic movements, types of intersections, islands, crossings and their design.
- Illustrate the design of signals and explain the redesigning of existing signals
- Provide an insight on traffic regulations, pollution caused by traffic and the method of controlling pollution

Particulars	**Hours**
Module 1: Introduction	**10**
Objectives and scope of traffic engineering, Components of road traffic - the vehicle, driver and road, Road user characteristics; human and vehicle characteristics, factors affecting road traffic; methods of measurement. Concepts of passenger car units for mixed traffic flow.	
Module 2: Traffic Engineering Studies and Analysis	**10**
Sampling in Traffic Studies, Adequacy of Sample Size; Objectives, methods of traffic study, equipment, data collection, analysis and interpretation (including case studies) of (i) Spot speed (ii) Speed and delay (iii) Volume (iv) Origin - Destination (v) Parking (vi) Accident studies.	
Module - 3 : Design of Traffic Engineering Facilities	**10**
Control of Traffic Movements through Time Sharing and Space Sharing Concepts; Design of Channelizing Islands, T, Y, Skewed, Staggered, Roundabout, Mini-roundabout and other forms of at-Grade Crossings including provision for safe crossing of Pedestrians and Cyclists; Grade Separated Intersections, their Warrants and Design Features; Design of Road Lighting.	
Module 4 :Traffic Control Devices:	**10**
Traffic signs, markings, islands and signals. Different methods of signal design; redesign of existing signal including case studies. Signal system and co-ordination.	
Module 5: Traffic Regulations and Control:	**10**
General regulations: Regulations on Vehicles, drivers and flow; Other regulations and control. Traffic management; noise and air pollution due to road traffic and method of control.	

TEXT BOOKS

1. Kadiyali, L.R. `Traffic Engineering and Transport Planning', Khanna Publishers.
2. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., `Highway Engineering', Nem Chand and Bros,Roorkee, 2014
3. Papacostas, C.A., 'Fundamentals of Transportation Engineering', Prentice-Hall of India Private Limited, New Delhi.2000.

REFERENCES

1. Partha Chakroborty and Animesh Das, 'Principles of Transportation Engineering', Prentice Hall (India),New Delhi, 2011.
2. Relevant IRC and MoRTH Publications.
3. Pignataro, Louis; 'Traffic Engineering-Theory and Practice', John Wiley.

PAVEMENT MATERIALS

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 - 2017)

SEMESTER - I

Subject Code	16CTE 12	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

COURSE OBJECTIVES:

- Explain the different types, properties and tests on soil subgrade
- Explain the properties of aggregates and different test procedures and specifications
- Explain the origin, properties, constituents and preparation of bitumen and tar
- Explain about cut back bitumen and bitumen emulsions, test procedures and the uses
- Explain mechanism of stripping, adhesion failures and methods to improve adhesion
- Illustrate the bituminous mix design method.
- Explain in detail about HMA, WMA, CMA
- Explain types of cement, tests on cement, types of concrete, fillers and sealers

Particulars	Hours
Module 1: Soil	**10**
Characterization: Properties of subgrade layers; different types of soils, Soil Classification; Index and other basic properties of soil; A critical look at the different laboratory and in - situ procedures for evaluating the mechanical properties of soils viz. SPT, CPT, CBR, Plate Load test, Field compaction and control.	
Module 2: Aggregates	**10**

Origin, classification, requirements, properties and tests on road aggregates, mechanical and shape properties of aggregates, Aggregate texture and skid resistance, polishing of aggregates; concepts of size and gradation - design gradation, maximum aggregate size, aggregate blending to meet specification, Fuller and Thompson's Equation, 0.45 power maximum density graph, Sampling of aggregates.	
Module - 3 : Bitumen	**10**
Bitumen and Tar: Origin, preparation, properties and chemical constitution of bituminous road binders; equirements, bitumen structure, Rheology of bitumen, Elastic modulus, Dynamic modulus, visco-elastic and fatigue properties, creep est, Bituminous Emulsions and Cutbacks, Preparation, characteristics, uses and tests, Adhesion of Bituminous Binders to Road Aggregates: Adhesion failure, mechanism of stripping, tests and methods of improving adhesion.	
Module 4 : Bituminous Mixes	**10**
Resilient and Complex (Dynamic) Moduli of Bituminous Mixes, Permanent Deformation Parameters and other Properties. Modified bitumen: Crumb Rubber Modified bitumen, Natural rubber modified bitumen, polymer modified bitumen; Long term and short term ageing and its effect on bitumen performance, Tests to simulate ageing of bitumen viz. RTFOT and PAV. Desirable properties of bituminous mixes, Design of bituminous mixes: Modified Marshall's specifications, Hubbard Field method of mix design, Hveem's method of mix design; Introduction to super pave mix design procedure, Modified binders, HMA, WMA, CMA	
Module 5 : Cement and Concrete	**10**
Types of cements and basic cement properties, Quality tests on cement; Tests on cement concrete including compressive strength, flexural strength, modulus of elasticity and fatigue properties; Introduction to advanced concretes like self compacted concrete, Light weight concrete, Roller Compacted Concrete for pavement application; Joint fillers and sealers for Jointed Plain Cement Concrete Pavements and their characterization.	

TEXT BOOKS

1. RRL, D S I R , ` Bituminous Materials in Road Construction', HMSO Publication
2. RRL, D S I R , ` Soil Mechanics for Road Engineers',H M S O Publication

REFERENCES

1. Khanna, S.K., Justo, C.E.G., and Veeraragavan,A., `Highway Engineering', Nem Chand and Bros, Roorkee, 2014.

2. Partha Chakroborty and Animesh Das, 'Principles of Transportation Engineering', Prentice Hall (India), New Delhi, 2011.

3. Atkins, N. Harold, Highway Materials, Soils and Concretes, Fourth Edition, 2002, Prentice – Hall

4. Freddy L Roberts, Prithvi S Kandhal et al, "Hot Mix Asphalt Materials, mixture design and construction" - (2^{nd} Edition), National Asphalt Pavement Association Research and Education Foundation, Maryland, USA.

4. Relevant IRC and MoRTH Publications.

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APPLIED SOIL MECHANICS AND GROUND IMPROVEMENT TECHNIQUES

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)
SEMESTER - I

Subject Code	16CTE 13	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

COURSE OBJECTIVES:

- Explain the origin, formation, classification of soil, index properties and their determination, types of soil exploration programmes
- Provide information shear strength of soil and its measurement, elastic properties of soil
- Explain various ground improvement techniques and the types of compaction and its effect on soil properties
- Explain the types of drains and various stabilization techniques
- Inform about the types of reinforcement and design principles, grouting techniques

Particulars	Hours
Module 1: Introduction To Soil Mechanics And Site Investigation	**10**
Soil Mechanics applications to Highway Engineering. Soil formations, Types, Regional Soil deposits of India, Index properties, their determination, importance, various soil classification systems, HRB classification, problems on these. Site Investigation: Introduction, Planning exploration programmes, Types of Exploration, Location and depth of Borings, Methods, Samplers, SPT, Subsoil investigation Report, Geophysical methods	
Module 2: Shear Strength Of Soil	**10**
Introduction, Importance, Measurements, shear strength of clay and Sand, Elastic properties of soil – Tangent, Secant modulus, Stress – Strain curves, Poisson's ratio, Shear Modulus	
Module - 3 : Ground Improvement	**10**
Definition, Objectives of ground improvement, Classification of ground improvement techniques Soil Compaction- Effect of grain size distribution on compaction for various soil types like lateritic soil, coarse-grained soil and micaceous soil. The Effects of compaction on engineering behaviour like compressibility, swelling and shrinkage, permeability, relative density, liquefaction potential. Field compaction – static, dynamic, impact and vibratory type. Shallow and deep compaction, Dynamic Compaction, Vibrofloatation	

Module 4 : Hydraulic Modification And Chemical Modification	**10**
Hydraulic modification –Definition, gravity drain, lowering of water table, multistage well point, vacuum dewatering. Vertical drains, Sand drains, Drainage of slopes, Electro kinetic dewatering, Preloading. Chemical modification – Definition, cement stabilization, sandwich technique, admixtures. Hydration – effect of cement stabilization on permeability, Swelling and shrinkage and strength and deformation characteristics,. Stabilization using Fly ash. Lime stabilization – suitability, process, criteria for lime stabilization. Other chemicals like chlorides, hydroxides, lignin and hydrofluoric acid. Bitumen, tar or asphalt in stabilization.	
Module 5: Soil Reinforcement	**10**
Earth reinforcement – Principles and mechanism of reinforced earth-reinforced soil retaining structures, Synthetic and natural fibre based Geotextiles and their applications - Filtration, drainage, separation, and erosion control. Design Principles of steep reinforced soil slopes – pavements – Embankments on soft soils, introduction to soil nailing concepts **Miscellaneous Methods (Only Concepts & Uses):** Grouting: Introduction, Effect of grouting. Chemicals and materials used. Types of grouting, Grouting procedure, Applications of grouting. Thermal methods, Crib walls, Gabions and Mattresses, Anchors, Rock bolts, Stone Column, Micropiles.	

TEXT BOOKS

1. Soil Mechanics and Foundation Engg. - Punmia B.C. (2005), 16th Edition Laxmi Publications Co., New Delhi.
2. Principles of Soil Mechanics and Foundation Engineering- Murthy V.N.S. (1996), 4th Edition, UBS Publishers and Distributors, New Delhi.

REFERENCES

1. Geotechnical Engineering; Braja, M. Das (2002), Fifth Edition, Thomson Business Information India (P) Ltd., India
2. Ground Improvement Techniques- Purushothama Raj P. (1999) Laxmi Publications, New Delhi
3. Construction and Geotechnical Method in Foundation Engineering- Koerner R.M. (1985) – Mc Graw Hill Pub. Co., New York.

URBAN TRANSPORT PLANNING
[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)
SEMESTER – I

Subject Code	16CTE 14	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

COURSE OBJECTIVES:

- Recall basic concepts and methods of urban transportation planning in the India.
- Summarize methods of designing, conducting and administering surveys to provide the data required for transportation planning.
- Examine and apply travel demand modeling, Mode Choice Modeling and Traffic Assignment Modeling.
- Formulate the need of land use modeling and illustrate land use models for urban transportation planning

Particulars	Hours
Module 1: Introduction	**10**
Introduction to transportation planning, scope and objective of UTP, various modes of transportation and comparisons, urban transportation system planning process, transportation demand and forecast.	
Module 2: Transportation Planning Process & Surveys	**10**
System approach to urban planning, Stages in transportation planning, Basic Movements-Study Area-Zones-Surveys-Planning of different types of surveys-Inventory of transportation facilities	
Module - 3 : Trip generation & Trip distribution	**10**
Trip generation: Trip purpose- Factors governing trip generation and attraction- Category analysis-Problems on above Trip distribution: Methods- Growth factors methods- Synthetic methods- Fratar and Furness method and problems on the above	
Module 4 : Model Split & Trip Assignment	**10**
Model Split: Factors affecting- characteristics of split- Model split in urban transport planning- problems on above Trip Assignment: Assignment techniques- problems on all techniques, minimum path tree problems.	
Module 5:	**10**
Interdependency of Land Use & transport, characteristics of land use Models–Lowry Model- Hansen's Accessibility Model-Density- Saturation Gradient Model-Problems(Exception Lowry Model & DSGM)-Difficulties in planning small & medium cities- Recent case studies	

TEXT BOOKS

1. Kadiyali L.R., Traffic Engineering and Transport Planning, Khanna Publishers
2. C. S. Papacostas, Fundamentals of Transportation System Analysis, PHI.
3. Khisty, C J., Transportation Engineering – An Introduction, Prentice-Hall, NJ

REFERENCES

1. B.G.Hutchinson, Principles of urban transportation system planning- McGraw-Hill, New York, 1974
2. S.C. Saxena, Traffic Planning and Design, DhanpatRai Pub., New Delhi.

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REMOTE SENSING AND GIS IN TRANSPORT PLANNING

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER - I

Subject Code	16CTE 151	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

COURSE OBJECTIVES:

- Explain the purpose of accurate mapping of all features under different spatial and temporal scales of all kinds of terrain and land under water bodies.
- Discuss on the advantages of remote sensing compared to traditional surveying techniques in terms of time, accuracy and output.
- Explain the purpose and methods of obtaining abstract data both spatial and temporally.
- Illustrate the application of GIS and remote sensing in solving real world transportation problems

Particulars	Hours
Module 1: Introduction to remote sensing	**8**
Definition – Components of Remote Sensing – Energy, Sensor, Interacting Body –Active and Passive Remote Sensing – Platforms– Aerial and Space Platforms –Balloons, Helicopters, Aircraft and Satellites – Electromagnetic Radiation– EMR Spectrum.	
Module 2: Introduction to GIS	**10**
Basic Concept and Components – Hardware, Software –Data Spatial and non-spatial – Geo-referencing – Map Projection – Types of Projection – Simple Analysis – Data retrieval and querying.	
Module - 3 : Data structures and analysis	**10**
Database – Raster and Vector data structures – Datastorage – Run length, Chain and Block coding – Vector data storage –	

Topology – GIS Modeling - Raster and Vector data analysis – Buffering and overlaying techniques – Network Analysis – Spatial Analysis	
Module 4 : Basic applications in transportation	**10**
Highway and Railway Alignment, location of transport terminals and roadside facilities, bus stops – Route optimization – Bus route rationalization – Accident analysis – Applications of Aerial Photography and Satellite Imageries	
Module 5: Advanced applications	**10**
GIS as an integration technology – Integration of GIS, GPS and Remote Sensing Techniques – Advanced Traveller Information System (ATIS) – Automatic Vehicle Location System (AVLS)	

TEXT BOOKS

1. Anji Reddy, Remote Sensing and Image Interpretation, John Wiley and Sons Inc. New York, 1987.
2. M.G.Srinivas, Remote Sensing Applications, Narosa Publishing House, 2001

REFERENCES

1. .Burrough P.A, Principles of GIS for Land ResourcesAssessment, Oxford Publication, 1994.
2. Jeffrey Star and John Ester, Geographical Information System – An Introduction, Prentice Hall Inc., Englewood Cliffe, 1990.
3. Marble, D.F, Calkins, H.W and Penquest, Basic Readings in GIS, Speed System Ltd., New York, 1984

RAILWAY INFRASTRUCTURE PLANNING AND DESIGNING

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)
SEMESTER - I

Subject Code	16CTE 152	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

COURSE OBJECTIVES:

- To understand the importance of railway infrastructure planning and design.

- To identify the factors governing design of railway infrastructures.
- To apply track design principles, components and design criteria
- To design and analyze the railway track system and signal system with the available methods.
- To maintain the railway track and apply remedial measures
- To execute the minor and major projects related to railway infrastructure.

Particulars	Hours
Module 1: Alignment of Railway Lines	**10**
Modes of transportation, developments in railways, classification of railway lines, railway track gauges, ideal alignment, traffic survey, reconnaissance survey, preliminary surveys, and engineering surveys, geometric design, gradients, grade compensation, speeds of trains, curves and superelevation, extra clearance on curves, widening of gauge on curves.	
Module 2: Permanent Way	**10**
Requirements, cross-sections, forces acting on the track, coning of wheels, tilting of rails, function of rails, types of rails, rail wear, defects in rails, creep of rails, rail fixtures and fastenings, ballast, functions, types, sizes, physical properties, subgrade and formation, slopes of formation, switches, tongue rails, crossing, angle of crossing, turnouts, inspection and maintenance, track junctions and track layouts, three-throw switch, design features of a turnout, crossings.	
Module 3 : Signalling and interlocking, Design of tracks for high speeds	**10**
Objectives, classification, fixed signals, stop signals, signalling systems, mechanical signalling system, electrical signalling system, systems for controlling train movement, interlocking, modern signalling installations. Modernization of railways, effect of high speed track, vehicle performance on track, high speed ground transportation system, ballast less track, elevated railways, underground and tube railways.	
Module 4 : Rolling Stock, Railway sections and yards	**10**
Types of traction, locomotives and other rolling stock, brake systems, resistance due to friction, wave action, wind, gradient, curvature, starting, Tractive effort of a locomotive, hauling power of a locomotive. Purpose, site selection, facilities, requirements, classification, platforms, building areas, types of yards, foot over bridges, subways, cranes, weigh bridge, loading gauge, end loading ramps, locomotive sheds, ash-pits, water columns, turntable, triangles, buffer stop, scotch block.	

Module 5 : Railway accidents, Track maintenance and Rehabilitation	**10**
Train accidents, derailments and its causes, restoration of traffic, safety measures, disaster management, classification of level crossings, accidents at level crossings, remedial measures, maintenance of level crossings. Maintenance tools, maintenance of rail surface, track drainage, maintenance in track circuited lengths, track tolerances, mechanized method of track maintenance, off -track tampers, shovel packing, directed track maintenance, classification of renewal works, through sleeper renewals, mechanized relaying, track renewal trains.	

TEXT BOOKS

1. Agarwal, M.M. Indian Railway Track, Prabha & Co., New Delhi, India, 1988.

2. Chandra S. and M.M. Agarwal Railway Engineering, Oxford University Press, New Delhi, India, 2007.

REFERENCES

1. Gupta, B.L. Text Book of Railway Engineering, Standard Publishers, New Delhi, India, 1982.
2. Rangwala, S.C. Principles of Railway Engineering, Charotar Publishing House, Anand, India, 1988.
3. S.C. Saxena and S.P. Arora, A text book of Railway engineering, Dhanpat Rai, 2001.
4. Satish Chandra and M. Agrawal, Railway Engineering, Second Edition, Oxford University Press, 2013.

ADVANCE CONCRETE TECHNOLOGY

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)
SEMESTER - I

Subject Code	16CTE 153	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

COURSE OBJECTIVES:

- This course will provide the students with state-of-the art knowledge on durable and sustainable cement and concrete,
- This course will empower students to become technical leaders in the concrete

Particulars	**Hours**
Module 1: Concrete Making Materials	**10**

Cement – Bogus Compounds – Hydration Process – Types of Cement – Aggregates – Gradation Charts – Combined Aggregate – Alkali Silica Reaction – Admixtures – Chemical and Mineral Admixtures.	
Module 2: Fresh and Hardened Concrete	**10**
Fresh Concrete – workability tests on Concrete – Setting Times of Fresh Concrete – Segregation and bleeding. Hardened Concrete: Abrams Law, Gel space ratios, Maturity concept – Stress strain behaviour – Creep and Shrinkage – Durability Tests on Concrete – Non Destructive Testing of Concrete.	
Module 3: High Strength Concrete	**10**
Microstructure – Manufacturing and Properties – Design of HSC Using Erintroy Shaklok method – Ultra High Strength Concrete. High Performance Concrete – Requirements and Properties of High Performance Concrete– Design Considerations.	
Module 4: Special Concretes	**10**
Self Compacting concrete, Polymer Concrete, Fibre Reinforced Concrete– Reactive Powder Concrete – Requirements and Guidelines – Advantages and Applications. Concrete Mix Design: Quality Control – Quality Assurance – Quality Audit - Mix Design Method – BIS Method – DOE Method – Light Weight Concrete, Self Compacting Concrete.	
Module 5: Form work	**10**
Materials – structural requests – form work systems – connections – specifications – design of form work – shores – removal for forms - shores – reshoring – failure of form work.	

REFERENCE BOOKS:

1. Special Structural concretes by **Rafat Siddique,** Galgotia Publications 2000.
2. Design of Concrete Mixes by **N.Krishna Raju**, CBS Publications, 2000.
3. Concrete: Micro Structure by **P.K.Mehta**, ICI, Chennai.
4. Properties of Concrete by **A.M.Neville**, ELBS publications Oct 1996.
5. Concrete Technology by **A.R. Santhakumar**, Oxford University Press Oct 2006.
6. Concrete Technology by **M.S.Shetty, S.Chand** & Co 2009.

INTELLIGENT TRANSPORTATION SYSTEMS

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER - I

Subject Code	16CTE154	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam	03

		Hours	

COURSE OBJECTIVES:

- Learn the objectives, benefits and the telecommunications in ITS.
- Learn about the functional areas, user needs and services in ITS.
- Learn the concepts of ITS operations and applications.

Particulars	**Hours**
Module 1: Introduction to Intelligent Transportation Systems (ITS)	**10**
Definition, Objectives, Historical Background, Benefits of ITS -ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.	
Module 2: Telecommunications in ITS	**10**
Information Management, Traffic Management Centers (TMC). Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centers; Sensor plan and specification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts	
Module - 3 : ITS functional areas, User Needs and Services –	**10**
Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS). Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.	
Module 4 : ITS Operations	**10**
Regional and Project ITS architecture; Concept of operations; ITS Models and Evaluation Methods; Planning and human factor issues for ITS, Case studies on deployment planning and system design and operation; ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS planning	
Module 5: ITS applications	**10**
Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.; Transportation network operations; commercial vehicle operations ; public transportation applications; Automated Highway Systems- Vehicles in Platoons –ITS in World – Overview of ITS implementations in developed countries.	

TEXT BOOKS

1. Choudury M A and Sadek A, "Fundamentals of Intelligent Transportation Systems Planning" Artech House.
2. Kan Paul Chen, John Miles, "Recommendations for World Road Association (PIARC)" ITS Hand Book 2000.

REFERENCES

1. Sussman, J. M., "Perspective on ITS", Artech House Publishers, 2005.
2. US Department of Transportation, "National ITS Architecture Documentation", 2007 (CD-ROM).
3. Turban. E and Aronson. J. E, "Decision Support Systems and Intelligent Systems", Prentice Hall

PAVEMENT MATERIALS TESTING LAB
[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2016 -2017)

SEMESTER - I

Subject Code	16CTE16	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

COURSE OBJECTIVES:

- Explain the properties of aggregates and different test procedure of conduction and specifications
- Explain procedures of conducting tests on neat bitumen and modified bitumen
- Explain Rothfutch method of marshal mix design
- Explain CBR test to know the strength characteristics of soil
- Explain procedure for different tests on cement and mix design

Particulars	Hours
Module 1: TESTS ON AGGREGATES	**10**
Basic tests such as crushing strength, abrasion value, impact value, combined index value, specific gravityand water absorption.	
Module 2: TEST ON NEAT AND MODIFIED BITUMEN	**10**
Basic tests on neat bitumen such as penetration, softening point, viscosity, ductility, flash and fire point and	

specific gravity. Basic tests on modified bitumen such as penetration, softening point, viscosity, elastic recovery, flash and fire point, specific gravity and loss on heating.	
Module 3 : TEST ON BITUMINOUS MIXES	**10**
Proportioning of materials by Rothfutch's method and Mix design by Marshall Method.	
Module 4 : TEST ON SOILS	**10**
CBR test.	
Module 5 : TEST ON CEMENT& CONCRETE	**10**
Basic tests on cement concrete such as workability test, soundness test, compressive strength, split tensile strength and flexural strength. Concrete mix design.	

REFERENCES

1. Relevant IS and IRC codes
2. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., `Highway Materials and Pavement Testing', Nem Chand and Bros, Roorkee
3. Gambhir, M. L., 'Concrete Manual', Dhanpat Rai and sons New Delhi

TRAFFIC ENGINEERING - 2

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER - II

Subject Code	16CTE21	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

COURSE OBJECTIVES:

- Learn the relationships between the parameters of traffic flow and the types of flow theories.
- Learn the concept of design vehicle and design volume to be considered along with the concept of roadway capacity and level of service.
- Learn the probabilistic aspects of vehicle arrivals, gap acceptance and delays.
- Learn the principles of traffic forecasting and simulation in traffic engineering.

Particulars	**Hours**
Module 1: Traffic Flow Theory	**10**

Fundamental flow relationship and their applications, Traffic flow theories and applications; Shock Waves; Queuing theory and applications.	
Module 2: Design Hourly Volume for Varying Demand Conditions:	**10**
Concept of Design vehicle units and concept of PCU under mixed traffic conditions, Price-volume relationships and demand functions. Design hourly volume, critical hour concept.	
Module - 3 : Highway Capacity	**10**
Factors affecting capacity, level of service; Capacity studies, Capacity of different highway facilities including un-signalized and signalized intersections. Problems in Mixed Traffic flow, Case studies.	
Module 4 : Probabilistic Aspects of Traffic Flow:	**10**
Vehicle arrivals, distribution models, gaps and headway distribution models; gap acceptance merging parameters, delay models, applications.	
Module 5: Traffic Forecast	**10**
General travel forecasting principles, different methods of traffic forecast-Mechanical and analytical methods, Demand relationships, methods for future projection. **Simulation:** Fundamental principle, application of simulation techniques in traffic engineering formulation of simulation models, Case studies. Formulation of system models.	

TEXT BOOKS

0. Kadiyali, L.R., 'Traffic Engineering and Transport Planning', Khanna Publications.
1. Papacostas, C.A., 'Fundamentals of Transportation Engineering', Prentice-Hall of India Private Limited, New Delhi.2000.

REFERENCES

1.Drew, D.R., 'Traffic Flow Theory and Control', McGraw Hill Book Co
2.Pignataro, Louis; 'Traffic Engineering-Theory and Practice', John Wiley.
3.William R. McShane and Roger P. Roess, Traffic Engineering', Prentice hall, New Jersey, 2000.

PAVEMENT DESIGN AND ANALYSIS

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER - II

Subject Code	16CTE22	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80

Total Number of Lecture Hours	50	Exam Hours	03

COURSE OBJECTIVES:

- Identify and categorize the factors affecting design and performance of pavements
- Explain the basic modeling concepts used to analyze flexible and rigid pavements.
- Explain different design methods for flexible and rigid pavement design

Particulars	**Hours**
Module 1: Introduction	**10**
Factors Affecting Pavement Design, Variables Considered in Pavement Design, Types of Pavements, Functions of Individual Layers, Classification of Axle Types, Tire Pressure, Contact Pressure, EAL and ESWL Concept, Lane Distributions & Vehicle Damage Factors, Effect of Transient & Moving Loads	
Module 2: Stresses And Deflections In Flexible Pavements	**10**
Stresses and deflections in homogenous masses. Burmister's two-layer theory, three layer and multilayer theories, Problems on above.	
Module - 3 : Flexible Pavement	**10**
Design Methods Principle, design steps, advantages and applications of different pavement design methods – Group Index, CBR, McLeod, Kansas Triaxial test, IRC, AASHTO and Asphalt Institute methods	
Module 4 : Stresses In Rigid Pavements	**10**
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. Problems on above.	
Module 5: Rigid Pavement Design	**10**
Types of joints in cement concrete pavements and their functions, joint spacing, design of CC pavement for roads and runways, design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method. Design of continuously reinforced concrete pavements. Problems on above	

TEXT BOOKS

1. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., `Highway Engineering', Nem Chand and Bros, Roorkee.
2. Yoder, E.J., and Witzack, 'Principles of Pavement Design', 2 nd Edition, John Wiley and Sons

REFERENCES

1. Yang, `Design of Functional Pavements', McGraw Hill Book Co.
2. Yang. H. Huang, 'Pavement Analysis and Design', Prentice Hall Inc

3. Relevant IRC and AASHTO publications

GEOMETRIC DESIGN OF TRANSPORTATION FACILITIES

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER - II

Subject Code	16CTE23	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

COURSE OBJECTIVES:

- Learn the importance of geometric design elements and the cross sectional elements.
- Learn the importance of sight distances and the components of horizontal and vertical alignment.
- Learn about the various types of intersections and their suitability.
- Learn about the various types of facilities for pedestrians, cycles, buses and parking.

Particulars	Hours
Module 1: Introduction	**10**
Functional Classification of Highway systems, Objectives of highway geometric design, elements of geometric design, design controls and criteria. **Cross Section Elements:** Pavement surface characteristics – skid resistance, cross slope, unevenness, light reflecting characteristics. Width considerations for carriageway, formation, shoulders, kerbs, traffic barriers, medians, frontage roads, right of way. Facilities for pedestrians and bicycles.	
Module 2: Sight Distances	**10**
Types, analysis, factors affecting and design of stopping sight distance, intermediate sight distance and overtaking distance. **Horizontal Alignment:** Design speed, stability at curves, analysis and design of super elevation, extra widening of pavements, design of transition curves, curvature at intersections	
Module - 3 : Vertical alignment	**10**
Classification of grades, change of gradients, design of summit curves for sight distance consideration, design of valley curves for comfort and sight distance considerations. Combination of vertical and horizontal alignment including design of hairpin bends, design standards for expressways and hill roads. IRC standards and guidelines.	

Module 4 : Design of Intersections	**10**
Types of intersections, characteristics and design considerations of at-grade intersections; different types of islands, channelization, median openings. Rotary intersections – warrants, design and suitability. Grade separated intersections - types, warrants and suitability. Interchanges and ramps.	
Module 5: Miscellaneous Facilities	**10**
Pedestrian facilities especially on urban – types, IRC specification. Bicycle tracks -types, guidelines, and IRC design standards. Bus bays - types, guidelines and IRC design standards. Parking facilities - types, guidelines and IRC design standards.	

TEXT BOOKS

1. AASHO, "A Policy on Geometric Design of Highways an d Streets', American Association of State Highway and Transportation Officials, Washington D.C.
2. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., `Highway Engineering', Nem Chand and Bros, Roorkee, 2014.

REFERENCES

1.DSIR`, Roads in Urban Areas', HMSO, London.
2.Jack E Leish and Associates, `Planning and Design Guide: At-Grade Intersections'. Illinois.
3.Relevant IRC publications

TRANSPORTATION ECONOMICS AND EVALUATION

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER - II

Subject Code	16CTE24	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

COURSE OBJECTIVES:

- Explain the basic terminology of economics and its application in transportation
- Define the concept and components involved in economic evaluation
- Explain the various methods of economic analysis and ranking of alternatives
- Illustrate the method of economic evaluation for transportation projects

Particulars	**Hours**

Module 1: Principles of Economics	**10**
Supply and demand models, Consumer's surplus and social surplus criteria, and framework for social accounting: accounting rate of interest, social opportunity cost, rate of interest, social time preference rate of interest, accounting prices of goods and services, measuring input costs, applications on social accounting.	
Module 2: Transport Costs and Benefits	**10**
Fixed and variable cost, cost of improvement, maintenance cost, cost estimating methods, accounting for inflation, external costs, Direct benefits: reduced vehicle operation costs, value of travel time savings, value of increased comfort and convenience, cost of accident reduction, reduction in maintenance cost.	
Module - 3 : Economic Analysis:	**10**
Generation and screening of project alternatives, different methods of economic analysis: annual cost and benefit ratio methods, discounted cash flow methods, shadow pricing techniques, determination of IRR and NPV, examples of economic analysis, application economic theory in traffic assignment problem.	
Module 4 : Project Evaluation	**10**
Framework of evaluation, transport planning evaluation at urban and regional levels, other evaluation procedures, environmental evaluation, safety evaluation, project financing.	
Module 5: Environmental impact assessment	**10**
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. Ian G. Heggie, Transportation Engineering Economics, McGraw Hill
2. Winfrey R, Highway Economic Analysis, International Textbook Company

REFERENCES

1. Road User Cost Study, Central Road Research Institute, New Delhi.
2. Dickey J.W, Project Appraisal for Developing Countries, John Wiley
3. L R Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
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ROAD SAFETY MANAGEMENT

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER - II

Subject Code	16CTE251	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

COURSE OBJECTIVES:

- Explain the causes of accidents, statistical measures of accident data analysis and computer application in data analysis
- Explain different parameters responsible for providing road safety in the construction of new roads
- Explain road reconstruction principle and improvement of road considering the different components of road and intersections
- Explain road safety and maintenance measures for road in operation considering pedestrian, cyclists and road furniture
- Explain road safety audit principle and procedure, various traffic management techniques and their effectiveness

Particulars	**Hours**
Module 1: Road accidents, Causes, Scientific Investigations and Data Collection	**10**
Analysis of Individual accidents to arrive at Real Causes, Statistical Methods of Analysis of Accident Data, Application of Computer Analysis of Accident Data.	
Module 2: Ensuring Traffic Safety in Designing New Roads	**10**
Meteorological Conditions, Structure of Traffic Streams, Orientation of a Driver on the Direction of a Road beyond the Limits of Actual Visibility and Roadway Cross Section & Objects on the Right-of-Way.	
Module - 3 : Ensuring Traffic Safety in Road Reconstruction	**10**
Road Reconstruction and Traffic Safety, Reconstruction Principles, Plotting of Speed Diagram for Working out Reconstruction Projects, Use of Accident Data in Planning Reconstruction of Roads, Examples of Reconstruction of Selected Road Sections for Improving Traffic Safety, Improving Traffic Conditions on Grades, Sharp Curves, Redesign of Intersections, Channelized At-Grade Intersections, Bus Stops, Parking & Rest Areas and Effectiveness of Minor Road Improvements.	
Module 4 : Ensuring Traffic Safety in Road Operation	**10**
Ensuring Traffic Safety during Repair and Maintenance, Prevention of Slipperiness and Influence of	

Pavement Smoothness, Restriction speeds on Roads, Safety of Pedestrians, Cycle Paths, Informing Drivers on Road Conditions with Aid of Signs, Traffic Control Lines & Guide Posts, Guardrails & Barriers and Road Lighting.	
Module 5: Road Safety Audit and **Traffic Management Techniques**	**10**
Principles- Procedures and Practice, Code of Good Practice and Checklists. Road safety issues and engineering, education, enforcement measures for improving road safety. Local area management, Various types of long term traffic management measures and their uses. Evaluation of the effectiveness and benefits of different traffic management measures, management and safety practices during road works.	

TEXT BOOKS

1. Babkov, V.F. 'Road conditions and Traffic Safety', MIR publications, Moscow - 1975.
2. K.W. Ogden, `Safer Roads – A Guide to Road Safety Engg.' Averbury Technical, Ashgate Publishing Ltd., Aldershot, England, 1996.

REFERENCES

1. Kadiyali, L.R., `Traffic Engineering and Transport Planning', Khanna Publications, New Delhi, 2009.
2. Jotin Kishty and B. Kent Lall, 'Transportation Engineering-An Introduction', Third Edition, Prentice Hall of India Private Limited, New Delhi, 2006
3. Latest Editions of Relevant Indian Roads Congress (IRC) Publications for Design of Roads and Road Safety.

APPLIED STATISTICS IN TRANSPORTATION ENGINEERING

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER - II

Subject Code	16CTE 252	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

COURSE OBJECTIVES:

- Explain different statistical methods used in transportation engineering problems, measures of central tendency, correlations methods

- Illustrate the use of probability and discrete distributions in transportation engineering problems
- Explain significance testing to check goodness of fit
- Explain time series analysis
- Explain different graphical methods and statistical software packages useful in transportation engineering field

Particulars	**Hours**
Module 1: Introduction	**10**
Statistical methods, scope and limitations, population and sample, frequency stribution measure of central tendency-measures of Dispersion- standard deviation, coefficient of variation, skewness. Variables -scatter diagram, Curve fitting methods, correlation linear regression and multiple linear regressions. Multivariate data analysis.	
Module 2: Probability	**10**
Review, Addition & Multiplication Rules, random Variables, Discrete distributions – Binomial & Poisson Distributions, Continuous Distribution – Uniform, Exponential, Gamma & normal Distributions, applications in transportation engineering problems.	
Module - 3 : Statistical decisions	**10**
hypothesis testing, significance levels – Tests concerning Mean, testing the equality of means of two populations, tests concerning the variance. Chi –square Test for goodness of fit Confidence Interval.	
Module 4 : Time series analysis-	**10**
Introduction –moving average- Problems	
Module 5: Optimization technique and applications	**10**
Graphical Method –Simplex Method-Big-M method-2 –Phase Simplex method- applications in transportation engineering problems. Use of Mathematical and statistical software packages	

TEXT BOOKS

1.Gupta, S.C. and Kapoor V.K. Fundamentals of Mathematical statistics, Sultan Chand and Sons, 1978.
2.Medhi J (1982) Introduction to statistics. New age publications, New Delhi

REFERENCES

1.Kadiyali L.R. Traffic Engineering and Transport Planning, Khanna Publishers, 2004
2. Johnson R and G. Bhattacharya (1985): Statistics – principles and methods. John Wiley, N Y,
3.Ross S. M. Probability and statistics for Engineers. Wiley Int. Edition

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ENVIRONMENTAL IMPACT ASSESSMENT OF TRANSPORTATION PROJECTS

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER - II

Subject Code	16CTE253	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

COURSE OBJECTIVES:

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

Particulars	**Hours**
Module 1: Introduction	**10**
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	
Module 2: Environmental Indicators	**10**
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.	
Module - 3 : Environmental Impact Assessment For **Transportation Projects**	**10**
Basic Concepts, Objectives, Transportation Related Environmental Impacts – Vehicular Impacts – Safety & Capacity Impacts – Roadway Impacts – Construction Impacts, Environment al Impact Assessment – Environmental Impact Statement, Environment Audit, Typical case studies	
Module 4 : Environmental Issues in Industrial Development	**10**

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	
Module 5: Methodologies for Carrying Environmental Impact Assessment	**10**
Overview of Methodologies, Adhoc Checklist, Matrix, Network, Overlays, Benefit Cost Analysis, Choosing a Methodology, Review Criteria.	

TEXT BOOKS

1. R. K. Urban, L. V., Stracy, G.S., (1991), "Environmental Impact Analysis", Van Nostrand Reinhold Co., NewYork
2. J.G. and Wooten, D. C., (1996), "Environmental Impact assessment", McGraw Hill Pub. Co., New York

REFERENCES

1. Canter L W., (1997), "Environmental Impact assessment", McGraw Hill Pub, Co., New York
2. Grand Jean, E. Gilgen A., "Environmental Factors in Urban Planning", Taylor and Francis Ltd, London, 1976.
3. UNESCO,(1987), " Metallurgical Guidelines for the Integrated Environmental Evaluation of Water Resource Development", UNESCO/UNEP, Paris

OPTIMIZATION TECHNIQUES

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER - II

Subject Code	16CTE 254	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

COURSE OBJECTIVES:

- To impart knowledge on different methods of optimization techniques, linear, non-linear, dynamic programming and use of network techniques.

Particulars	Hours
Module 1: Introduction to Optimization	**10**
Introduction - Historical developments - Engineering applications of Optimization - Statement of an Optimization problem - Classification of Optimization problems - Optimization Techniques. Optimization by calculus: Introduction - Unconstrained functions of a single variable - Problems involving simple constraints -	

Unconstrained functions of several variables – treatment of equality constraints - Extension to multiple equality constraints – Optimization with inequality constraints - The generalized Newton-Raphson method.	
Module 2: Linear Programming	**10**
Introduction - Applications of linear programming - standard form of a linear programming problem - Geometry of linear programming problems - Definitions and theorems - Solution of a system of Linear simultaneous equations - Pivotal reduction of a general system of equations - Motivation of the Simplex Method - Simplex Algorithm - Two phases of the simplex method.	
Module 3: Non-Linear Programming	**10**
Introduction - Unimodal Function - Unrestricted search - Exhaustive search - Dichotomous search - Interval Halving method - Fibonacci method - Golden section method - Comparison of elimination methods - Unconstrained optimization techniques - Direct search methods - Random search methods - grid search method - Univariate method - Powell's method - Simplex method - Indirect search methods - Gradient of a function - Steepest descent method - Conjugate gradient - Newton's method.	
Module 4: Dynamic Programming	**10**
Introduction - Multistage decision processes - concept of sub-optimization and the principle of optimality - computational procedure in dynamic programming - example illustrating the Calculus method of solution - example illustrating the Tabular of solution - conversion of a final value problem into an initial value problem - continuous dynamic programming - Additional applications.	
Module 5: Network Analysis	**10**
Introduction - Elementary graph theory - Network variables and problem types - Minimum-cost route - Network capacity problems - Modification of the directional sense of the network, Application of Optimization Techniques.	

REFERENCE BOOKS:

1. Optimization: Theory and Applications by **S.S. Rao.** New Age International (p) Ltd.
2. Numerical Optimization Techniques for Engineering Design with applications by **G.N.Vanderplaats 2007.**
3. Elements of Structural Optimization by **R.T. Haftka and Z. Gurdal Kluwer** academic publishers.
4. Optimum Structural Design by **U.Kirsch.** Tata Mc Graw Hill.
5. Optimum Design of Structures by **K.I. Majid.**
6. Introduction to Optimum Design by **J.S. Arora.** Academic press, 2012 ISBN: 978-0-12-381375-6

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TRANSPORTATION ENGINEERING LAB
[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER – II

Subject Code	16CTE26	IA Marks	25
Number of Lecture Hours/Week	03	Exam Marks	50
Total Number of Lecture Hours	12	Exam Hours	03

COURSE OBJECTIVES:

- Illustrate the application of software for analyzing traffic survey data
- Explain and illustrate generation of models for transportation planning
- Explain arrival of economic cost of road projects
- Introduce the methods of designing geometry of highways using computer software

Particulars	**Hours**
Module 1: ANALYSIS OF TRAFFIC SURVEYS	**3**
1. Classified volume count survey 2. Moving car method 3. Parking studies 4. Origin-destination studies 5. LOS study	
Module 2: TRANSPORTATION PLANNING	**3**
1. Trip generation modeling 2. Mode choice/modal split problems 3. Trip assignment problems	
Module - 3 : TRANSPORTATION ECONOMICS	**3**
1. Vehicle operating costs 2. Toll pricing	
Module 4 : HIGHWAY GEOMETRY	**3**
1. Design of horizontal alignment, vertical alignment, generating cross section and design of intersections	

TEXT BOOKS

1. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., "Highway Engineering", Nem Chand and Bros, Roorkee.

REFERENCES

1. Relevant IRC publications
2. C.S.Papacostas and P.D.Prevedouros "Transportation engineering & Planning", PHI learning

PAVEMENT CONSTRUCTION TECHNOLOGY

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER – IV

Subject Code	16CTE41	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

COURSE OBJECTIVES:

- Explain concept of location surveys, procedure of preparing project report, documentation of contracts
- Explain features, functioning and uses of different types of equipments used in road construction and construction specification for different layers of road
- Provide information on specifications of construction of different types of granular sub base, base and surface course and construction of special pavement
- Provide information on application of CPM and PERT in construction planning
- Explain the maintenance activities for road and road furniture

Particulars	Hours
Module 1:	**10**
Importance of surveys and investigations, Guidelines for alignment and route location, Use of aerial photographs and remote sensing technology, Conventional ground survey techniques, Types of drawings, Estimates, Project reports, Project Cost Forecasting, Cost Optimization and Resources Planning, Tendering and Contracting, Laws of Contracts, Subcontracts, Potential Problems, Post Contract Problems, Documents, Conditions, Arbitration, Special Features of International Contracts. ; Human Resource Management, Resource Management and Inventory: Basic concepts, labor requirements and productivity.	
Module 2:	**10**
Road construction equipment – different types of ex cavators, 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.	
Module - 3 :	**10**
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.	
Module 4 :	**10**
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	
Module 5:	**10**
Principle of construction planning, application of CPM and PERT, Problems, Road maintenance works – day to day and periodic maintenance works o f various components of road works and road furniture	

TEXT BOOKS

1. Peurifoy.R.L., 'Construction Planning, Equipment and Methods', McGraw Hill Publishers, New York, 2000
2. S.C.Sharma, ' Construction Equipment and its Management', Khanna Publishers, New Delhi, 1988

REFERENCES

1. Asphalt Technology and Construction Practices, The Asphalt Institute, Maryland, USA, 1997
2. Relevant IS, IRC, AASHTO and MoRTH Publications.

URBAN MASS TRANSPORT SYTEMS

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER – IV

Subject Code	16CTE421	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80

Total Number of Lecture Hours	40	Exam Hours	03

COURSE OBJECTIVES:

- Explain different transit modes, routing management activities including demand analysis
- Provide information on functioning, designing and scheduling of transit terminal design, fleet management, cost benefit analysis and bus transit operation
- Provide information on loading and unloading transit platforms, traffic management techniques and IPT service improvements
- Explain demand management techniques, intersection management techniques, planning for pedestrian, bicycle and parking management

Particulars	Hours
Module 1: Transit Classifications	**10**
Classes of Transit Modes, Technologies, Service Types, and routing Management Activities: Service, Finance, Marketing, Maintenance, Demand Analysis, Transit Subsidies.	
Module 2: Terminals	**10**
Design, Functional Aspects, and Scheduling of Transit Units. Efficiency and Effectiveness Indicators for Transit Planning: System, Subsystem, and Route Level Analyses, Staff Utilization, Fleet Utilization and Productivity, Passengers Carried, Revenue, Operating Costs, and Break-Even Load, Capacity Utilization, Financial Performance indicators, Cost-Benefit Analysis. Bus transit operations.	
Module - 3 :	**10**
Planning, routing and scheduling, Location of loading and unloading platforms and transit terminals. Transport System Management Actions: Traffic management techniques for improving vehicular flows, preferential treatment for high occupancy modes, promoting non auto or high occupancy use, and transit and intermediate public transport service improvements.	
Module 4 :	**10**
Demand management techniques for reduced traffic demand staggered hours, and vehicle restrictions; Intersection management techniques: signal progression, optimization and computer controls	
Module 5:	**10**

Small area Management, Management of Bicycles, planning for pedestrians and planning for parking spaces	

TEXT BOOKS

1. Vukan, R. and Vuchic, A. 'Urban Public Transport Systems and Technology'.
2. Morlok, E.K. 'Introduction to Transportation Engineering and Planning', McGraw Hill

REFERENCES

1.Transportation Systems Management: State of the Art, UMTA, US Dept. of Transport
2.C. S. Papacostas and P. D. Prevedouros, 'Transportation Engineering and Planning', PHI Publications
3.S. Grava, 'Urban Transportation Systems', Mc Graw Hill.

PAVEMENT EVALUATION AND MANAGEMENT

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER – IV

Subject Code	16CTE422	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

COURSE OBJECTIVES:

- Recall the importance of evaluation and strengthening of pavements
- Introduce the various methods of structural and functional evaluation of rigid and flexible pavements
- Discuss the need for pavement management and explain the techniques involved
- Formulate the development and application of models for pavement management.

Particulars	Hours
Module 1: Pavement Evaluation	**10**
Introduction- Structural and functional requirements of flexible and rigid pavements; pavement distress; different types of failures, causes and remedial measures.	
Module 2: Functional evaluation of pavements	**10**
Evaluation of Surface Condition: Methods of evaluating pavement surface condition, PCI & PSI, measurement of skid resistance and unevenness by various methods, their applications	

Module - 3 : Structural evaluation of pavements	**10**
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.	
Module 4 : Pavement management	**10**
Historical Background -General nature and applicability of systems methodology, basic components of Pavement Management System, planning pavement investments. Design Strategies - Framework for pavement design – design objectives and constraints.	
Module 5: Basic structural response models	**10**
Characterization of physical design inputs – generating alternative pavement design – economic evaluation of alternative design – analysis of alternative design strategies – selection of optimal design strategy. Techniques for developing prediction models – AASHTO, CRRI and HDM models	

TEXT BOOKS

1.Yoder, E.J., and Witzack, 'Principles of Pavement Design', 2 nd Edition, John Wiley and Sons
2.Ralph Haas, W.Ronald Hudson and John Zaniewski, Modern Pavement Management, Kreigar Publishing Company, New York

REFERENCES

1. M.Y.Stalin, Chapman and Hall Pavement Management for Airports, Roads and Parking Lots, New York
2. Michael Sargious, Pavements and surfacings for Highways and Airports, Applied Science Publishers Limited, London, 1975

APPLICATIONS OF SOFT COMPUTING TECHNIQUES

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER - IV

Subject Code	16CTE423	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

COURSE OBJECTIVES:

- Understand the characteristics of Soft Computing Techniques.
- Explain the concept of applying fuzzy logic and fuzzy reasoning for decision making.
- To understand concept of Genetic Algorithm.

Particulars	Hours
Module 1:	**10**
Introduction, need for soft computing techniques, components of soft computing	
Module 2:	**10**
Artificial Neural Networks (ANN), types of ANN and learning algorithms, tasks performed by ANN Basic concepts of feed forward neural networks, perceptron learning rule, back propagation learning algorithm, application of feed forward ANN for function approximation and prediction, limitations of feed forward neural networks, applications of feed forward neural networks in Hydrology, Water Resources and Environmental Engineering	
Module 3:	**10**
Hebbian learning and Hopfield networks, pattern association, radial basis function networks, Kohonen networks and self organisation maps, applications of ANN in pattern classification.	
Module 4:	**10**
Information and uncertainty, Chance versus ambiguity, Classical sets and fuzzy sets, Logic and reasoning, Fuzzy set operations and fuzzy relations, Membership Functions, fuzzy numbers and fuzzy arithmetic.	
Module 5:	**10**
Fuzzy Systems, fuzzy relations, fuzzy inference systems, Decision Making with Fuzzy Information, Fuzzy Classification and Pattern Recognition, Neuro-Fuzzy Systems Evolutionary computing, concepts of genetic algorithm, components of genetic algorithm, Hybrid soft computing techniques, Applications in Civil Engineering	

REFERENCE BOOKS:

1. **Haykin,** Neural Networks: A Comprehensive Foundation, Prentice Hall India, New Delhi, 2008
2. **Jang, J.R, Sun Chuen-tsai, and Mizutani Eiji,** Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, PHI Learning, 2009
3. **Rajasekaran, S., and Vijayalakshmi Pai, G.A.,** Neural Networks, Fuzzy Logic and Genetic Algorithms – Synthesis and Applications, Prentice-Hall India, New Delhi, 2003

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017

RURAL ROADS

[As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2016 -2017)

SEMESTER – IV

Subject Code	16CTE424	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

COURSE OBJECTIVES:

- Explain the concept and objective of providing low cost roads in developing country like India
- Explain problems involved in the design of rural roads, preparation of rural road development plans and economic viability
- Explain different types of surveys required for road alignment and road geometry with appropriate specifications
- Introducing different materials used for construction and different types of construction procedures and equipment required for construction
- Explain importance of road drainage, design of drainage and cross drainage structures with maintenance activities

Particulars	Hours
Module 1: Introduction	**10**
Concept Objective, Scope and coverage of low cost and rural roads. Explain significance of low cost roads for developing countries, with special reference to India	
Module 2: Rural Road Planning and Investment	**10**
Problems associated with planning of low volume rural roads in India .Rural road network planning-principles and methods. Socio-economic aspects in planning, preparation of rural road master plans and their evaluation: stage construction, planning and utilization of successive investments.	
Module - 3 : Location Surveys and Geometrics Design	**10**
Location surveys, geometric design standards for rural roads, special considerations for rural roads in hilly area.	
Module 4 : Materials	**10**
Stabilized soils, Design of soil-lime, soil-cement, soil-bitumen and soil-lime-fly ash mixes, Use of soft aggregates. Construction, Operation and Plants: Surveying and setting, excavation, hauling, Shaping and compaction, Stabilized soils-spreading, mixing and compaction. Appropriate technology, tools, plants and equipment for construction as per IRC practices.	
Module 5: Road Drainage and Maintenance	**10**

Drainage of road surface, pavement layers and cross drainage works. Various low cost drainage alternatives. Short term routine maintenance, long term maintenance, organizational and financial aspects of maintenance works.	

TEXT BOOKS

1. IRC SP 20, 'Rural Roads Manual, Indian Roads Congress', New Delhi, 2002.
2. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., `Highway Engineering', Nem Chand and Bros, Roorkee

REFERENCES

1 Relevant IS, IRC, AASHTO and MoRTH Publications.