



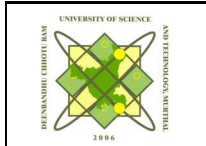
**DEENBANDHU CHHOTU RAM UNIVERSITY OF SCIENCE & TECHNOLOGY, MURTHAL, SONEPAT**

**SCHEME OF STUDIES & EXAMINATIONS  
CREDIT BASED SCHEME W.E.F. 2013-14**

**M. Tech in CIVIL ENGINEERING (Highway Safety and Engineering) Ist Semester**

S. No.	Course Code	Course Title	Teaching Schedule		Sessional Marks	Examination Marks		Total	Credit	Duration of Examination
			L	P		Theory	Practical			
1	CEH-501	Pavements Design	4	-	25	75	-	100	4	3
2	CEH-503	Highway Materials	4	-	25	75	-	100	4	3
3	CEH-505	Geometric Design	4	-	25	75	-	100	4	3
4	CEH-507	Traffic Engineering	4	-	25	75	-	100	4	3
5	CEH-509	Pavements Construction and Maintenance	4	-	25	75	-	100	4	3
6	CEH-511	Traffic Engineering Lab	-	3	20	-	30	50	1.5	3
7	CEH-513	Highway Materials Lab	-	3	20	-	30	50	1.5	3
<b>TOTAL</b>			<b>20</b>	<b>6</b>	<b>165</b>	<b>375</b>	<b>60</b>	<b>600</b>	<b>23</b>	

Note: Students will be allowed to use Non-Programmable Scientific Calculator. However, sharing of calculator will not be permitted in the examination.



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**SCHEME OF STUDIES & EXAMINATIONS**  
Credit Based Scheme w.e.f. 2013-14

**M. Tech in CIVIL ENGINEERING (Highway Safety and Engineering) IInd Semester**


S. No.	Course Code	Course Title	Teaching Schedule		Sessional Marks	Examination Marks		Total	Credit	Duration of Examination
			L	P		Theory	Practical			
1	CEH-502	Transport Planning	4	-	25	75	-	100	4	3
2	CEH-504	Public Private Partnership concepts in Road Infrastructure	4	-	25	75	-	100	4	3
3	CEH-506	Road Safety and Audit	4	-	25	75	-	100	4	3
4	CEH	Elective-I	4	-	25	75	-	100	4	3
5	CEH	Elective-II	4	-	25	75	-	100	4	3
6	CEH-508	Road Safety and Audit Lab	-	3	20	-	30	50	1.5	3
<b>TOTAL</b>			<b>20</b>	<b>3</b>	<b>145</b>	<b>375</b>	<b>30</b>	<b>550</b>	<b>21.5</b>	

Course Code	Elective I
CEH-552	Traffic Management and Intelligent Transport Systems
CEH-554	Systems and Operational Research Methods in Transportation
CEH-556	Transportation data analysis
CEH-558	Composite Materials

Course Code	Elective II
CEH-572	Mass Transportation Systems
CEH-574	Advanced Methods in Road and airfield Infrastructure Design
CEH-576	Low volume Roads
CEH-578	Highway Sub grade and Foundation Analysis
CEH-580	Probability and Statistics

Note:


1. Students will be allowed to use Non-Programmable Scientific Calculator. However, sharing of calculator will not be permitted in the examination.
2. The choice of students for any elective shall not be binding on the department.

		<b>DEENBANDHU CHHOTU RAM UNIVERSITY OF SCIENCE &amp; TECHNOLOGY, MURTHAL, SONEPAT</b>  <b>SCHEME OF STUDIES &amp; EXAMINATIONS</b> <b>Credit Based Scheme w.e.f. 2014-15</b>								
<b>M. Tech in CIVIL ENGINEERING (Highway Safety and Engineering) IIIrd Semester</b>										
S. No.	Course Code	Course Title	Teaching Schedule		Sessional Marks	Examination Marks		Total	Credit	Duration of Examination
			L	P		Theory	Practical			
1	CEH-601	Environmental and Social Impact Assessment of Highway Projects	4	-	25	75	-	100	4	3
2	CEH-603	GIS in Highway Engineering	4	-	25	75	-	100	4	3
3	CEH-	Elective-III	4	-	25	75	-	100	4	3
4	CEH-605	GIS Lab	-	3	20	-	30	50	1.5	3
5	CEH-607	Seminar	-	2	50	-	-	50	2	3
6	CEH-609	Dissertation(Phase I)	-	6	100	-	-	100	6	3
Total			16	11	245	225	30	500	21.5	

Course Code	Elective III
CEH-651	Road Transport Regulations and Administration
CEH-653	Highway Drainage Systems
CEH-655	Design and construction of bridges and flyovers
CEH-657	Accident Analysis
CEH-659	Road Safety and Corridor Management

Note:

1. Students will be allowed to use Non-Programmable Scientific Calculator. However, sharing of calculator will not be permitted in the examination.
2. The choice of students for any elective shall not be binding on the department.
3. Dissertation coordinator will be assigned the load of 1 hrs per week excluding his own guiding load. However, the dissertation guiding teacher will be assigned a load of one hr per candidate per week subject to the maximum of two period of teaching load irrespective of number of students/groups under him/her.

		<b>DEENBANDHU CHHOTU RAM UNIVERSITY OF SCIENCE &amp; TECHNOLOGY, MURTHAL, SONEPAT</b> <b>SCHEME OF STUDIES &amp; EXAMINATIONS</b> <b>Credit Based Scheme w.e.f. 2014-15</b>								
<b>M. Tech IVth Semester (Highway Safety and Engineering)</b>										
S. No.	Course Code	Course Title	Teaching Schedule		Sessional Marks	Examination Marks		Total	Credit	Duration of Examination
			L	P		Theory	Practical			
1	CEH-610	Dissertation	-	20	50	-	100	150	20	3
		Total	-	20	50	-	100	150	20	

**Note:**

1. Dissertation coordinator will be assigned the load of 1 hrs per week excluding his own guiding load. However, the dissertation guiding teacher will be assigned a load of one hr per candidate per week subject to the maximum of two period of teaching load irrespective of number of students/groups under him/her.

## CEH- 501: PAVEMENT DESIGN

<b>L</b>	<b>P</b>	<b>Credits</b>
<b>4</b>	<b>0</b>	<b>4</b>

<b>Class Work</b>	<b>25 Marks</b>
<b>Examinations</b>	<b>75 Marks</b>
<b>Duration of Exam 3 Hrs</b>	

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### UNIT I

**Road Pavements and pavement layers** - Types of pavements. Flexible and rigid pavements. Components of a pavement and their functions.

**Pavement design factors:** Factors affecting design of pavements types, functions, choice. Factors affecting design and performance of flexible and rigid pavements: loads - axle load distribution, ESWL, EWL, VDF due to varying loads and traffic conditions.

### UNIT II

**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.

### UNIT III

Design of Flexible Pavements: Empirical, semi empirical and theoretical design approaches, principle, advantages and application. Design steps by CBR method as per IRC. outline of other common methods of Flexible Pavement design such as AASHTO and Asphalt Institute methods, Group Index method, Triaxial method and Burmister's method.

### UNIT VI

Stresses in rigid pavements: Stresses Due to Wheel Loads and Temperature Variations. Westergaard's theory, critical locations of loading, load and temperature stresses. Critical combination of stresses.

Design of Cement Concrete Pavements: IRC guidelines for determination of thickness of a rigid pavement. Joints: requirements, types, patterns. Spacing of expansion and contraction joints. Functions of dowel and tie bars. Design features of CRCP, SFRC and ICBP.

Various types of Overlays, Design of Overlays.

### TEXT/REFERENCE BOOKS:

1. Khanna and Justo, "Highway Engineering"- Nem Chand and Bros., Roorkee
2. Yoder and Witczak, "Principles of Pavement Design"- John Wiley and sons Inc(second edition) 1975
3. MoRTH 'Specifications for Roads and Bridges Works'- Indian Roads Congress
4. Yang, "Design of functional pavements"- Mc Graw Hill Book Co.
5. Huang, "Pavement Analysis"- Elsevier Publications
6. David Croney, Paul Croney, "Design & Performance of Road Pavements"- Mc Graw hill Book Co.
7. IRC 37-2001, IRC 81-1997, IRC 58 - 2002, IRC 59 - 1976, IRC 101-1988.

### Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed

## CEH- 503 HIGHWAY MATERIALS

<b>L</b>	<b>P</b>	<b>Credits</b>
<b>4</b>	<b>0</b>	<b>4</b>

<b>Class Work</b>	<b>25 Marks</b>
<b>Examinations</b>	<b>75 Marks</b>
<b>Duration of Exam 3 Hrs</b>	

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### UNIT I

Soils: Characteristics of soil, Centrifuge moisture equivalent, Colour, Field moisture equivalent, Grain shape, Lineal shrinkage and volumetric change, Particle sizes and distribution, Plasticity, Presence of fines, Specific gravity, State of compaction. Grain or particle size classification, Textural classification, Highway research Soil classification systems board classification of soils, Indian Standard soil classification Soil stabilizers: Bituminous materials, Cementing agents, Chemical stabilizers

Aggregates: Types of road aggregates, Requirements of a good road aggregate, Tests for road aggregates.

### UNIT II

Bituminous Materials: Asphalt, Bitumen, Cutback bitumen, Bitumen emulsion, Tar, Road oil, Primers, Manufacturing of bitumen, Functions of bituminous materials, Tests for bituminous materials.

Portland cement – types, source, functions, requirements, properties, tests and specifications for use in various components of road.

### UNIT III

Low Cost Materials: Earth roads, Kankar roads, Gravel roads, Moorum roads, Traffic bound or dry bound macadam, Water bound macadam and water mix macadam.

Polymer and Rubber Modified binders: Physical and chemical properties. Marginal and waste materials in road construction, properties and scope. Performance based mix design Approaches. Visco-elastic properties of bitumen and bituminous mixture.

### UNIT IV

Soil stabilized roads: use of geo-synthetics. Use of Fly-ash in road embankment and cement concrete mixes, Innovative Materials.

Mix design: Proportioning of materials, Requirement of bitumen mixes, design of bituminous mix, Marshall method, Hubbard method, Rothfutch method of bituminous mix design.

### TEXT/REFERENCE BOOKS:

1. Khanna and Justo, "Highway Engineering" - Nem Chand and Bros., Roorkee
2. Khanna and Justo, "Highway Materials Testing" - Nem Chand and Bros., Roorkee.
3. "Soil Mechanics for Road Engineers" - HMSO Publication
4. "Bituminous materials in Road Construction" - HMSO Publication
5. MoRTH "Manual for Construction and Supervision of Bituminous Works"- 2001, Indian Roads Congress
6. MoRTH "Manual for Maintenance of Roads"- 1989, Indian Roads Congress
7. Maintenance, repair, rehabilitation of rigid pavements, IRC: SP 83

### Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CEH- 505 GEOMETRIC DESIGN

L	P	Credits	Class Work	25 Marks
4	0	4	Examinations	75 Marks
				Duration of Exam 3 Hrs

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### UNIT I

Introduction: Classification of rural highways and urban roads. Objectives and requirements of highway geometric design: Design Control and Criteria.

Cross Section Elements: Right of way and width considerations, roadway, shoulders, kerbs traffic barriers, medians, frontage roads; Facilities for pedestrians, bicycles, buses and trucks, Pavement surface characteristics - types, cross slope, skid resistance, unevenness.

### UNIT II

Sight distances - types, analysis, factors affecting, measurements, Horizontal alignment--design considerations, stability at curves, super-elevation, widening, transition curves; curvature at intersections.

### UNIT III

Vertical alignment - grades, ramps, design of summit and valley curves, combination of vertical and horizontal alignment including design of hair pin bends.

### UNIT IV

Geometric design of cycle tracks, Design of pedestrian subways and over bridges and ramps. Geometric design of parking facilities. Design of Expressways, IRC standards and guidelines for design, Design considerations for rural roads and urban arterials: design speeds, volumes, levels of service and other design considerations.

### TEXT/REFERENCE BOOKS:

1. Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna publishers
2. Salter, R J., Highway Traffic Analysis and Design, ELBS
3. The Institute of Transportation Engineers, Transportation and Traffic Engg. Hand Book, Prentice Hall (1982) Chapters 8,17,21,23 and 24.
4. IRC-SP41: Guidelines for the Design of At-Grade Intersections in Rural & Urban Areas
5. Edward K. Morlock, Introduction to Transportation Engineering & Planning, International Student Edition, Mc-Graw Hill Book Company, New York.
6. Joseph, De Chiara, Urban Planning and Design Criteria, Van Nostrand Reinhold, 1982.

### Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CE-507: TRAFFIC ENGINEERING

**L**      **P**      **Credits**  
**4**      **0**      **4**

**Class Work**      **25 Marks**  
**Examinations**      **75 Marks**  
**Duration of Exam** **3 Hrs**

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### UNIT I

Traffic Characteristics, road user characteristics – human factors including reaction time and vehicular characteristics affecting road design and traffic flow.

Traffic studies - data collection, analysis and interpretation of results of classified traffic volume, spot speed, speed and delay, origin and destination and parking studies, Sampling in traffic studies. Evaluation of improvement measures by "before and after studies".

### UNIT II

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

Traffic flow theory – scope, relationship between flow variable, bottle necks, Queuing theory and applications; vehicle arrivals, delays at intersections, Elements of simulation technique in traffic Engineering.

### UNIT III

Traffic Control Devices: Traffic signs and markings and road lightings. Different types of Traffic islands, channelization; median openings, Delineators, Barriers and other road furniture.

Design of at Grade Intersections: Characteristics and design considerations of at-grade intersections; Rotary intersections; Design of signal phasing.

### UNIT IV

Grade separations and interchanges - Types, warrants, adaptability and design details; Interchanges - different types, ramps. Computer applications for intersection and interchange design.

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, Traffic Calming measures.

#### TEXT/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. Nicholas J Garber, Lester A Hoel, "Traffic & Highway Engineering"- Third edition, Bill Stenquist.
4. Khanna and Justo, "Highway Engineering"- Nem Chand and Bros., Roorkee
5. IRC: SP:41-1994, IRC SP:31-1992, IRC 43-1994, Indian Roads Congress
6. 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

#### Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.



## CEH-509: PAVEMENT CONSTRUCTION AND MAINTENANCE

L	P	Credits	Class Work	25 Marks
4	0	4	Examinations	75 Marks
			Duration of Exam	3 Hrs

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### UNIT I

**Earthwork Machinery:** Brief introduction to earthwork machinery: shovel, hoe, clamshell, dragline, bulldozers, cleaning and grubbing, excavation for road and drain, principles of field compaction of embankment/subgrade, compacting equipments.

**Construction of Granular and Low Cost Roads:** soil stabilization techniques, Construction steps of GSB, WBM and WMM.

### UNIT II

**Construction of bituminous pavements:** various types of bituminous constructions. Prime coat, tack coat, seal coat and surface dressing. Construction of premix carpet, BM, DBM and AC.

**Machinery for Construction of Bituminous Roads:** bitumen boiler, sprayer, pressure distributor, hot-mix plant, cold-mix plant, tipper trucks, mechanical paver or finisher, rollers. Mastic asphalt. Introduction to various IRC and MORTH specifications.

### UNIT III

**Construction of cement concrete roads:** construction of cement concrete pavements, machinery involved in construction, slip-form pavers, and joints in CC pavements, IRC and MORTH specifications.

**Construction of other types of pavements:** basic concepts of the following: reinforced cement concrete pavements, prestressed concrete pavements, roller compacted concrete pavements and fibre reinforced concrete pavements. Use of fly ash in cement concrete road construction.

### UNIT VI

**Highway maintenance:** pavement distresses, condition and evaluation survey, Present serviceability index, Methods of measuring condition, skid resistance, Principles of maintenance, Methods of structural evaluation. Maintenance operations. Maintenance of WBM, bituminous surfaces and cement concrete pavements. Functional and structural evaluation of pavements, pavement maintenance, maintenance management.

Special problems in construction & maintenance of hill roads, land slide, causes, investigation, and preventive and remedial measures, protection of embankment and cut slopes. Drainage – Construction of surface and subsurface drainage system for roads. Drainage of urban roads.

#### TEXT/REFERENCE BOOKS:

1. Khanna and Justo “**Highway Engineering**” - Nemchand & Bros, Roorkee
2. Khanna and Justo, “**Highway Materials Testing**”- Nem Chand and Bros., Roorkee.
3. Peurifoy, R.L., and Clifford, JS “**Construction Planning Equipment and Method**”- McGraw Hill Book Co. Inc.
4. MoRTH ‘**Specifications for Roads and Bridges Works**’ - Indian Roads Congress
5. “**Soil Mechanics for Road Engineers**”- HMSO Publication
6. “**Bituminous materials in Road Construction**”- HMSO Publication

7. W.Ronald Hudson, Ralph Haas and Zeniswki "**Modern Pavement Management**"- Mc Graw Hill and Co.
8. MoRTH "**Manual for Construction and Supervision of Bituminous Works**"- 2001.
9. MoRTH "**Manual for Maintenance of Roads**"- 1989.
10. *Maintenance, repair, rehabilitation of rigid pavements*, IRC: SP 83
11. 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.

**Note:**

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

### CEH-511: TRAFFIC ENGINEERING LAB

<b>L</b>	<b>P</b>	<b>Credits</b>	<b>Class Work</b>	<b>20 Marks</b>
	<b>3</b>	<b>1.5</b>	<b>Examinations</b>	<b>30 Marks</b>
			<b>Duration of Exam</b>	<b>3 Hrs</b>

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#### **List of experiments:**

1. Traffic volume count
2. Classified traffic volume count
3. Parking study
4. Intersection turning movements
5. Spot speeds
6. Speed and delay Study
7. Study of Performa for Road side interview method
8. Study of Performa for house hold interviews method
9. Before and After studies
10. Study of form A-1
11. Study of form 4

#### **Note:**

The students will be required to carry out at least 8 experiments / exercises selecting from the above list and any other two experiments either from the above list or designed by the department based on the theory course.

## CEH-513: HIGHWAY MATERIALS LAB

<b>L</b>	<b>P</b>	<b>Credits</b>	<b>Class Work</b>	<b>20 Marks</b>
	<b>3</b>	<b>1.5</b>	<b>Examinations</b>	<b>30 Marks</b>
			<b>Duration of Exam</b>	<b>3 Hrs</b>

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### List of Experiments:

1. Granular mix design by Trial and Error Method to achieve the specified gradings
2. Bituminous mix design by Marshall Method
3. Shape test.
4. Water absorption and specific gravity tests.
5. Penetration test.
6. Ductility test.
7. Softening point test.
8. Flash & fire point test.
9. CBR test.

### Note:

The students will be required to carry out at least 6 experiments / exercises selecting from the above list and any other two experiments either from the above list or designed by the department based on the theory course.

## CEH- 502: TRANSPORT PLANNING

<b>L</b>	<b>P</b>	<b>Credits</b>	<b>Class Work</b>	<b>25 Marks</b>
<b>4</b>	<b>0</b>	<b>4</b>	<b>Examinations</b>	<b>75 Marks</b>
			<b>Duration of Exam</b>	<b>3 Hrs</b>

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### UNIT I

**Transportation Planning Process:** Characteristics of different modes of transportation; Elements in urban transit system. Introduction to transport planning, Status of transportation in India, Objectives and scope of transport planning, Urban, regional and national transport planning. Transport planning process, various stages. Land use and transportation planning; zoning and development control exercise; designing for sustainability. Land use transportation models: introduction to Lorry model.

### UNIT II

**Transport Surveys:** Definition of study area. Zoning. Types of surveys. O-D surveys. Inventories of existing transport facilities, land use and economic activities.

**Trip Generation:** Classification of trips, Factors governing trip generation and attraction; Zonal models; Trip generation estimation by multiple linear regression analysis, brief review of category analysis, advantages and limitations of these methods.

### UNIT III

**Trip Distribution:** Methods of trip distribution. Basic concepts of uniform factor method, average factor method and opportunity model. Trip distribution by gravity model.

**Traffic Assignment:** principles of traffic assignment; Assignment techniques Principles of assignment. Assignment techniques. All or nothing assignment. Brief review of multipath assignment, capacity restraint assignment and diversion curves.

**Modal Split:** General considerations for modal split. Factors affecting modal split. Brief Introduction to various methods of modal split.

### UNIT IV

**Evaluation:** Need for evaluation. Several plans to be formulated. Testing. Considerations in evaluation. Economic evaluation, basic principles, brief introduction to various methods of economic evaluation, comparison.

**Regional Network Planning:** Network Characteristics – Circuitry, Connectivity, Mobility, Accessibility, Network Structures and Indices – Network Planning – Evaluation - Graph Theory Applications

### TEXT/REFERENCE BOOKS:

1. Hutchinson, B.G., "Principles of Urban Transport System Planning" – McGraw Hill Book Co.
2. Kadiyali, L.R., "Traffic Engineering and Transportation Planning" – Khanna Publication.
3. Institute of Traffic Engineers – "An Introduction to highway Transportation Engineering".
4. Introduction to Transport Planning by Bruton, M.J., Hutchinson Technical Education, London.

### Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CEH- 504: PUBLIC PRIVATE PARTNERSHIP CONCEPTS IN ROAD INFRASTRUCTURE

L	P	Credits
4	0	4

Class Work	25 Marks
Examinations	75 Marks
Duration of Exam	3 Hrs

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### UNIT I

**Highway Planning in India** – Objects, need for highway planning, types of planning, planning surveys, Interpretation, Preparation of Master plans, NTP and NTPC in India. 20 year road development plan including 1<sup>st</sup> and 2<sup>nd</sup> 20 year plan in brief and 3<sup>rd</sup> and 4<sup>th</sup> 20 year plan in detail. Sources of finance for development and maintenance of road infrastructure. Principles of road use charging, central and state road funds, toll financing and toll policy.

**Highway Engineering Economics:** principle, supply and demand models, equilibrium, sensitivity of travel demand and elasticity – 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.

### UNIT II

**Economic analysis:** different methods, determination of annual cost, benefit cost ratio, IRR, FIRR, NPV. Sensitivity of economic analysis, risk and uncertainties and management decision in capital budgeting. 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.

**PPP concepts:** Basic concepts of Public Private Partnerships and Built-Operate-Transfer Models: BOT(Toll), BOT(Annuity), Shadow Tolls, DBFO concepts, maintenance – operate – and transfer models. Concerns of various stakeholders – government, concessionaire, lenders and road users. Legal and financial framework. Viability gap funding.

### UNIT III

**Risk Allocation and Mitigation:** Identification, allocation and mitigation of risks in delivery of BOT projects in road sector. Rights and obligations of parties. Rights of lenders. Model Concession Agreement. Dispute resolution mechanism.

**Procurement of PPP projects:** Preparation of Feasibility Reports covering technical, social and environmental aspects (for 2lane/4lane/6lane/Expressway) including procurement of consultancy services. Technical schedules for inviting bids for selection of sponsor. Preparation of RFQ, RFP. Bidding criteria. Selection of sponsor. Award of concessions. Pre-construction activities viz. Land Acquisition, Rehabilitation and resettlement of project affected persons, tree cutting, environment management plan, utilities shifting, etc.

### UNIT IV

**Financial Issues:** Financial assessment (by Government, by prospective bidders and by selected sponsor). Revenue and traffic projections. Cash flow Models including cost recovery, sensitivity analysis. Financial structuring, debt and equity aspects, financial close. Shareholders agreement. Case Studies.

**Contract Management:** Principles of contract management for PPP projects. Basic differences between FIDIC conditions of contract and Model Concession Agreement. Selection and Role of Independent Engineer.

**Recommended References:**

1. Kadiyali L.R. "**Traffic Engineering and Transport Planning**"-Khanna Publishers, New Delhi
2. Ian G. Heggie, "**Transportation Engineering Economics**"-McGraw Hill Book Co.
3. Jotin Chisty.C and Kent Lall B "**Transportation Engineering An Introduction**" - PHI, New Delhi.
4. Prasanna Chandra "**Financial Management**"-Tata McGraw, New Delhi.
5. Woods, K.B., Berry, D.S. and Goetz, W.H., "**Highway Engineering**"-McGraw Hill Book Co.
6. Hewes, C.I. and Oglesby, C.H., "**Highway Engineering**"-Asia Publishing House.
7. "**Road User Cost Study in India**"- Final Report, Central Road Research Institute, New Delhi, 1982.
8. Ministry of Road Transport and Highways, "**Road Development Plan for India**"- 2001-2021, Indian Roads Congress, New Delhi, 2002.

**Note:**

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CEH- 506: ROAD SAFETY AND AUDIT

L      P      Credits  
4      0      4

Class Work      25 Marks  
Examinations      75 Marks  
Duration of Exam 3 Hrs

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### UNIT I

Introduction: Road Safety scenario in India and World, Road Accident Characteristics.

Need of Planning for Network, Land Use and Road Environment for Safety, Designing for Safety: Road Link Design, Junctions.

### UNIT II

Introduction to Road Safety Engineering and Crash Investigation, Human Factors Relating to Crashes/ Accidents, Crash/ Accident Investigation & Crash Problem Diagnosing, Crash Problems into Solutions & Crash, Investigation Reporting, Crash/ Accident Costing, Economic Appraisal.

**Safety at Construction Site:** Safety provisions for workers at construction site, Construction Zone markings, signs.

### UNIT III

Street Lighting & Traffic Signals, Provisions for NMT Vehicles in India, Safety Provisions for Pedestrians & Cyclists, Road Signs and Pavement Markings.

Safe System Approach- A Global Perspective, Speed Management & safety, Safe System and Speed & Assessing speed limit, Type of speed limit & Speed zone signing Infrastructure to support safe speed feedback and enforcement.

### UNIT IV

**Road Safety Auditing:** An Introduction, Concept and need of Road Safety Audit (RSA). Procedures in RSA, design standards, audit tasks, stages of road safety audit, Road Safety Audit Types, key legal aspects, process, audit team and requirements, Checklist, how to use Checklists Road Safety inspection. Road design issues in RSA's. Overview of Road Safety Hazards. Report Writing including deficiency identification, corrective actions recommendations, prioritisation. Structuring RSA report.

Hazard Identification and Management, Organizational commitment & encouraging RSA. Risk Assessment & Prioritization of audit recommendations, Solutions and effectiveness & Corrective, Action Report.

TEXT/REFERENCE BOOKS:

1. Highway Engineering by Khanna and Justo, Nem Chand & Brothers, Roorkee
2. BABKOV, V.F. 'Road conditions and Traffic Safety', MIR publications, - 1975.
3. K.W. Ogden, 'Safer Roads - A Guide to Road Safety Engg.' Averbury Technical, Ashgate Publishing Ltd., Aldershot, England, 1996.
4. Kadiyali, L.R., 'Traffic Engineering and Transport Planning', Khanna Publications.
5. Pignataro, Louis, 'Traffic Engineering - Theory and Practice', John Wiley.
6. RRL, DSIR, 'Research on Road Safety', HMSO, London.
7. IRC Third 'Highway Safety Workshop', Lecture Notes 1978 and other IRC publications.
8. Papacoastas 'Introduction to Transportation Engineering' -Prentice



## 9. Road safety audit Manual

**Note:**

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

CEH-508: ROAD SAFETY AND AUDIT LAB

<b>L</b>	<b>P</b>	<b>Credits</b>	<b>Class Work</b>	<b>20 Marks</b>
	<b>3</b>	<b>1.5</b>	<b>Examinations</b>	<b>30 Marks</b>
			<b>Duration of Exam</b>	<b>3 Hrs</b>

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**List of experiments:**

1. Design stage audit: Study of project Drawings to identify safety concerns
2. Site Visits for Construction stage audit
3. Site Visits for existing road audit
4. Site Visits and Preparation of the Audit Reports
5. Visit to accident site
6. Compilation of FIR data and study of its limitations
7. Identification of black spots from FIR data
8. Study of accident recording forms

**Note:**

The students will be required to carry out at least 6 experiments / exercises selecting from the above list and any other two experiments either from the above list or designed by the department based on the theory course.

## CEH- 601: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT OF HIGHWAY PROJECTS

<b>L</b>	<b>P</b>	<b>Credits</b>	<b>Class Work</b>	<b>25 Marks</b>
<b>4</b>	<b>0</b>	<b>4</b>	<b>Examinations</b>	<b>75 Marks</b>
			<b>Duration of Exam</b>	<b>3 Hrs</b>

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### UNIT I

Environmental effects of transport; problems of identification; Environmental Impact Assessment: Evaluation of environmental impact due to construction. of new facilities and the effect of traffic thereon due to Bypasses, widening/four laning, expressway; grade separators. Assessment and attenuation.

### UNIT II

Noise; vibration; air pollution; Air pollution. emission levels, air- pollution dispersion, The box model, noise generation, noise measurement, noise propagation and mitigation strategies, noise measures, mathematical models of transportation noise, energy consumption and related issues. Environmental traffic management. Co-ordinated signal system on urban arterial road intersections to reduce air pollution.

### UNIT III

Pedestrian delay and danger; severance; accidents; Visual intrusion and aesthetics; Toxic freight; construction effects.

### UNIT IV

Land consumption and land-use effects; planning blight and compensation; Global climate, energy and resource use; and sustainability, GoI policies and requirements for clearances for Raod projects.

### TEXT/REFERENCE BOOKS:

1. CANTER, L.W., Environmental impact assessment, McGraw-Hill, 1997
2. Betty Bowers Marriott, Environmental Impact Assessment: A Practical Guide, McGraw-Hill Professional, 1997.
3. Peter Morris & Riki Therivel, Methods of Environmental Impact Assessment, Routledge, 2001.
4. Denver Tolliver, Highway Impact Assessment, Greenwood Publishing Group, 1993.
5. R. K. Jain, L. V. Urban, G. S. Stacey, H. E. Balbach, Environmental Assessment, McGraw-Hill Professional, 2001.

### Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CEH- 603: GIS IN HIGHWAY ENGINEERING

L	P	Credits	Class Work	25 Marks
4	0	4	Examinations	75 Marks
				Duration of Exam 3 Hrs

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### UNIT I

Remote sensing : Physics of remote sensing, Ideal remote sensing system, Remote sensing satellites and their data products, Sensors and orbital characteristics, Spectral reflectance curves, resolution and multiconcept, FCC, Interpretation of remote sensing images.

Digital image processing : Satellite image - characteristics and formats, Image histogram, Introduction to image rectification, Image enhancement, Land use and land cover classification system.

### UNIT II

Geographic information system (GIS) : Basic concept of geographic data, GIS and its components, Data acquisition, Raster and vector formats, Topography and data models, Spatial modelling, Data output.

Global positioning system (GPS) : Introduction, Satellite navigation system, GPS- space segment, Control segment, User segment, GPS satellite signals, Receivers; Static, Kinematic and Differential GPS.

### UNIT III

Implementing a GIS: Awareness, Developing System Requirements, Evaluation of alternative systems, System justification and Development of an implementation plan, System acquisition and start up, Operation of the system.

### UNIT IV

Applications in Transportation Engineering I: Intelligent Transport System, Urban Transport Planning, Highway Alignment, Traffic Congestion analysis and Accident Studies.

Applications in Transportation Engineering II: Environmental impact assessment, Transport System Management, Road Network Planning, Collecting Road Inventory.

#### TEXT/REFERENCE BOOKS:

1. GIS A Management, Perspenfi Stan Aronoff, WDL Publisher.
2. Peter A Burrough Rachael A Mc Donnel, "**Principles of GIS**" (Oxford), 2000.
3. Christopher Jones, "**GIS and Computer cartography**" (Longman), 2000.
4. Lillesand, "**Remote sensing and image interpretation**" (John Wiley and Sons), 2000.

#### Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

**CEH- 605: GEOMETIC ENGINEERING LAB**

<b>L</b>	<b>P</b>	<b>Credits</b>	<b>Class Work 20 Marks</b>
	<b>3</b>	<b>1.5</b>	<b>Examinations 30 Marks</b> <b>Duration of Exam 3 Hrs</b>

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1. Study of Total Station
2. Study of GPS.
3. Study of Arial photographs.
4. Study and image interpretation of remote sensing data.
5. Introduction to GIS software
6. Introduction to Image Processing Software.
7. To find out shortest route with GIS softwares
8. To find out best route with GIS softwares
9. Black spot identification using GIS
10. Accident analysis using GIS

**Note:**

The students will be required to carry out at least 8 experiments / exercises selecting from the above list and any other two experiments either from the above list or designed by the department based on the theory course.

## CEH - 607: SEMINAR

L	P	Credits	Class Work	: 50 Marks
-	02	02		

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The objective of this course is

- To learn how to carry out literature search
- To learn the art of technical report writing
- To learn the art of verbal communication with the help of modern presentation techniques

A student will select a topic in emerging areas of Structural Engineering and will carry out the task under the supervision of a teacher assigned by the Department.

He/she will give a seminar talk/presentation on the same topic before a committee constituted by the Chairperson of the Department. The committee should comprise of 2-3 faculty members. The faculty associated in the committee will each be assigned 2hrs teaching load/week. However, supervision of seminar topic will be in addition to the regular teaching load.

**CES-609      DISSERTATION PHASE I**  
**M.Tech. Semester – III (Structural Engineering)**

<b>L</b>	<b>P</b>	<b>Credits</b>	<b>Class Work</b>	<b>: 100 Marks</b>
-	06	06		

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The primary objective of this course is to develop in student the capacity for analysis and judgment and the ability to carry out independent investigation in design/development through a dissertation work involving creativity, innovation and ingenuity. The work must start with comprehensive literature search and critical appreciation thereof so as to select research problem the student wishes to work on.

Each student will carry out independent dissertation under the supervision of some teacher(s) who will be called Supervisor(s). In no case more than two supervisors can be associated with one dissertation work.

The dissertation involving design/testing/computer simulation/case studies etc. which commences in the IIIrd semester will be completed in IV semester. The evaluation of the dissertation phase I besides approval of the dissertation topic of the students will done by a committee constituted as under

- Chairperson of Department                      : Chairperson
- M.Tech. Coordinator/Sr. Faculty                : Member Secretary
- Respective dissertation supervisor            : Member

The student will be required to submit two copies of his/her report to the Department for record.

## CEH-610: DISSERTATION

L	P	Credits	Class Work	:	50 Marks
-	20	20	Examination	:	100 Marks
			Total	:	150 Marks
			Duration of Examination	:	3 Hours

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The dissertation started in III Semester will be completed in IV Semester and will be evaluated in the following manner.

### Internal Assessment

Internal Assessment (class work evaluation) will be evaluated as per ordinance through interim report, presentation and discussion thereon by the following committee of three persons

Chairperson of Department	:	Chairperson
M.Tech. Coordinator/Sr. Faculty	:	Member Secretary
Respective dissertation supervisor	:	Member

### External Assessment

Final dissertation will be assessed by a panel of examiners consisting of the following:

Chairperson of Department	:	Chairperson
Respective Supervisor(s)	:	Member(s)
External Expert	:	To be appointed by the University

Note: The external expert must be from the respective area of specialization. The Chairperson, M.Tech. Coordinator and respective supervisor(s) with mutual consultation will divide the submitted dissertations into groups depending upon the area of specialization and will recommend the list of experts for each group separately to the VC for selecting the examiners with the note that an external expert should be assigned maximum of FIVE dissertations for evaluation.

The student will be required to submit THREE copies of his/her report to the M.Tech Coordinator for record and processing.



## CEH- 552: TRAFFIC MANAGEMENT AND INTELLIGENT TRANSPORTATION SYSTEMS

<b>L</b>	<b>P</b>	<b>Credits</b>	<b>Class Work</b>	<b>25 Marks</b>
<b>4</b>	<b>0</b>	<b>4</b>	<b>Examinations</b>	<b>75 Marks</b>
			<b>Duration of Exam 3 Hrs</b>	

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### UNIT I

Introduction to Intelligent Transportation Systems (ITS) -Definition of ITS and Identification of ITS 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.

### UNIT II

Telecommunications in ITS - Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Vehicle - Road side communication - Vehicle Positioning System ITS functional areas - 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).

### UNIT III

ITS User Needs and Services - Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency and incident Management, Advanced Vehicle safety systems, Information Management.

### UNIT IV

Automated Highway Systems - Vehicles in Platoons - Integration of Automated Highway Systems. ITS Programs in the World - Overview of ITS implementations in developed countries, ITS in developing countries.

#### TEXT/REFERENCE BOOKS:

- 1 ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
- 2 Sussman, J. M., Perspective on ITS, Artech House Publishers, 2005.
- 3 National ITS Architecture Documentation, US Department of Transportation, 2007 (CD-ROM).

#### Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CEH- 554 SYSTEMS AND OPERATIONAL RESEARCH METHODS IN TRANSPORTATION

L	P	Credits	Class Work	25 Marks
4	0	4	Examinations	75 Marks
				Duration of Exam 3 Hrs

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### UNIT I

Network flows: Applications, definitions, graphs, paths, trees, cycles, loops, walk, network representation (adjacency list and matrices) and basic network transformations;

Network algorithms; Complexity, Search Algorithms, Strategies for designing polynomial algorithms.

### UNIT II

Shortest Path Algorithms: Label setting, Dijkstra's and Dial's algorithms, Optimality conditions, label correcting algorithms and optimality conditions, detecting negative cycles, all-pair shortest path algorithms; pre-flow push polynomial time algorithms, capacity scaling techniques.

### UNIT III

Minimum cost network assignment: optimality conditions, cycle-cancelling algorithm, Successive shortest path algorithm, other polynomial time variants;

Network equilibrium analysis; principles and optimisation formulations, Frank-Wolfe algorithm; Special cases and variants.

### UNIT IV

Applications: Applications of min-cost, max-flow, and shortest path algorithms to transportation and infrastructure networks: transportation networks, airline, freight, facility location, logistics, network design, project scheduling, reliability of distribution systems, telecommunication/power networks etc. Queuing theory, Computer Software.

### TEXT/REFERENCE BOOKS:

1. Ahuja, R., Magnanti, T.L., and Orlin, J.B., Network Flows: Theory, Algorithms and Application, Prentice Hall, New Jersey, 1993.
2. Bell, M.G., Transportation Networks, Elsevier Science Publishers, 1999.
3. Operation research by Kanti Swarup, Gupta and Manmohan.
4. Operation research and statistical analysis by S.D.Sharma on mental impact assessment.

### Note:

3. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
4. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CEH- 556: TRANSPORTATION DATA ANALYSIS

<b>L</b>	<b>P</b>	<b>Credits</b>	<b>Class Work</b>	<b>25 Marks</b>
<b>4</b>	<b>0</b>	<b>4</b>	<b>Examinations</b>	<b>75 Marks</b>
			<b>Duration of Exam</b>	<b>3 Hrs</b>

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### UNIT I

Multivariate Data Analysis Techniques: Types of Data, Basic Vectors and Matrices, Sample Estimate of Centroid, Standard Deviation, Dispersion, Variance and Covariance, Correlation Matrices, Principle Component, Factor Analysis, ANOVA and Cross Classification Procedure in Multivariate Data Analysis and Application to Problems in Traffic and Transportation Planning.

### UNIT II

Analysis and Modeling of Travel Choices: Fundamentals of Micro-Economic Demand Theory – Choice Function – Direct and Cross Elasticity of Demand – Properties of some Empirically Derived Demand Functions – Market Demand; Theory of Behavioral Models, Deterministic and Stochastic Models, Random Utility Model, Probit, Logit and Discriminant Model Formulations for Mode and Route Choices, Implications; Value of Travel Time Studies.

### UNIT III

Concept of Entropy and its Application in Travel Demand Modeling: Definition of Entropy, its relations to Probability and Uncertainty, Entropy of Probability Distribution, Entropy and Bayesian Statistics, Application of Entropy Concepts in Transport Models: Theory of Trip Distribution, Mode Split and Route Split, Production, Attraction, Doubly Constrained Gravity Models and Derivation of Intervening Opportunity Model, Missing Information and Use of Entropy in Travel Demand Modeling: Entropy and Information Theory Approaches for Estimating the Travel Demand using Indirect Methods such as Use of Link Volume Counts, Turning Counts, etc.

### UNIT IV

Forecasting using Time Series Analysis: Basic Components of Time Series – Stationery and Non-Stationery Processes- - Smoothing and Decomposition Methods – Correlation and Line Spectral Diagrams – Auto Correlations and Moving Averages; Introduction to Box-Jenkins Forecasting

#### TEXT/REFERENCE BOOKS:

1. Cooley, WW and Lohnes, RR, Multi-variate Data Analysis, John Wiley.
2. Richard A. Johnson, Dean W. Wichern, Applied Multivariate Statistical Analysis, Prentice Hall.
3. Simon P. Washington, Matthew G. Karlaftis & Fred L. Mannering, Statistical and Econometric Methods for Transportation Data Analysis, Chapman & Hall/CRC.
4. Kanafani, A., Transportation Demand Analysis, McGraw-Hill.
5. Michael Meyer, Eric J Miller, Urban Transportation Planning, McGraw-Hill
6. Spyros G. Makridakis, Steven C. Wheelwright, Rob J Hyndman, Forecasting : Methods and Applications, Wiley.

#### Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

### CEH-558: COMPOSITE MATERIALS

L	P	Credits	Class Work	: 25 Marks
4		4	Examination	: 75 Marks
			Total	: 100 Marks
			Duration of Examination	: 3 Hours

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#### UNIT-1

FIBRE REINFORCED CONCRETE: Properties of Constituent Materials, Mix Proportions, Mixing and Casting Procedures, Properties of Freshly mixed FRC, Mechanics and properties of Fibre reinforced concrete, Composite Material approach, Application of fibre reinforced concrete.

#### UNIT-II

FLY ASH CONCRETE: Classification of Indian Flyashes, Properties of Flyash, Reaction Mechanism, Proportioning of Flyash concretes, Properties of Flyash concrete in fresh and hardened state, Durability of flyash concrete.

#### UNIT-III

POLYMER CONCRETE: Terminology used in polymer concrete, Properties of constituent materials, Polymer impregnated concrete, Polymer modified concrete, Properties and applications of polymer concrete and polymer impregnated concrete.

FERRO CEMENT: Constituent materials and their properties, Mechanical properties of ferro cement, Construction techniques and application of ferro cement.

#### UNIT-IV

HIGH PERFORMANCE CONCRETE: Materials for high performance concrete, Supplementary cementing materials, Properties and durability of high performance concrete, Introduction to silica fume concrete, Properties and applications of silica fume concrete.

LIGHT WEIGHT CONCRETE: Properties of light weight concretes, Pumice concrete, Aerated cement mortars, No fines concrete, Design and applications of light weight concrete.

#### References:

1. Concrete Technology-A.M. Neville
2. Concrete Technology-M.L. Gambhir.

#### Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CEH- 572: MASS TRANSPORTATION SYSTEMS

<b>L</b>	<b>P</b>	<b>Credits</b>	<b>Class Work</b>	<b>25 Marks</b>
<b>4</b>	<b>0</b>	<b>4</b>	<b>Examinations</b>	<b>75 Marks</b>
			<b>Duration of Exam</b>	<b>3 Hrs</b>

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### UNIT I

**Role of Transportation:** History of transit, Recent Trends in transit, Mass transportation characteristics, Demand Characteristics: Spatial, temporal and behavioral characteristics.

**Mass Transportation Planning:** Transportation demand surveys, Mass transportation demand estimation, Demand projection, Trip generation, Trip distribution, Model split and route assignment. Bus scheduling, Transit corridor identification.

### UNIT II

**Transport system Performance:** Performance evaluation and analysis, Structure of decision making, Evaluation and selection methods, and selection procedure.

Generation of alternative schemes, Economic evaluation methods.

### UNIT III

**Terminals:** Public transport infrastructures, Functions of terminals, Design, Typical Terminal characteristics.

**Scheduling and Routes:** Service analysis, Vehicle dispatch policy, Vehicle Requirements, Spacing of bus stops, Route spacing and performance.

### UNIT IV

**Management:** Operational and management issues in transport planning, integration of public transport modes, Reserved bus lanes and signals, Vehicle monitoring and control system, Nodal coordination. BRT corridors.

**Special Systems:** Multimodal transport systems, People mover systems, Underground transportation, para transit, Rail transit system, case studies.

#### TEXT/REFERENCE BOOKS:

1. Khisthy, Lal, Transportation Engineering, PHI, Delhi, 2008 Hay, W.W., An Introduction to Transportation Engineering, 2nd Ed., John Wiley & Sons, 2001
2. Kadiyali, L. R, "Traffic Engineering and Transport Planning", Khanna Publishers New Delhi - 110006, 2006
3. Hutchinson, Urban Transport Planning, John Wiley, 2006
4. Dickey, J.W., et. al., Metropolitan Transportation Planning, TMH edition, 2002.
5. Pagnette, R.J., et.al, Transportation Engineering - Planning and design, 2<sup>nd</sup> Ed., John Wiley & Sons.
6. Railis, V.R, Intercity Transport, Engineering and Planning, The Macmillan Press, 2003.

#### Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CEH- 574: ADVANCED METHODS FOR AIRPORT INFRASTRUCTURE DESIGN

L      P      Credits  
4      0      4

Class Work      25 Marks  
Examinations      75 Marks  
Duration of Exam 3 Hrs

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### UNIT I

**Introduction:** Growth of air transport, airport organization and associations, Classifications of airports airfield components, airport traffic zones and approach areas.

**Aircraft Characteristics Related to Airport Design:** Components, size turning radius, speed, airport characteristics

### UNIT II

**Capacity and Delay:** Factors affecting capacity, Determination of runway capacity related to delay, gate capacity, taxiway capacity

**Airport planning and surveys:** Runway length and width, sight distances, longitudinal and transverse grades, runway intersections, taxiways, clearances, aprons, numbering, holding apron.

### UNIT III

**Design of the Terminal area:** Operational concepts, space relationships and area requirements, noise control, 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.

### UNIT IV

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

#### TEXT/REFERENCE BOOKS:

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

#### Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CEH- 576: LOW VOLUME ROADS

L	P	Credits	Class Work	25 Marks
4	0	4	Examinations	75 Marks
			Duration of Exam	3 Hrs

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### UNIT I

**Planning of rural road net work** – Concept of core and non-core roads, general principle, guidelines laid down in recent 20-year plans and in PMGSY

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

### UNIT II

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

### UNIT III

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

### UNIT IV

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

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

### TEXT/REFERENCE BOOKS:

1. CRRRI “**Low Volume Roads’ Central Road Research Institute**”-New Delhi
2. IRC “**Rural Roads Manual**”-Special Publication 20 – 2002, Indian Roads Congress.
3. IRC SP- 26 “**Report Containing Recommendations of IRC Regional Workshops on Rural Road Development**”- 1984, Indian Roads Congress
4. IRC SP:42 –1994, “**Guidelines on Road Drainage**” - Indian Roads Congress
5. IRC SP: 58-2001, “**Guidelines for Use of Fly Ash in Road Embankments**”- Indian Roads Congress
6. MoRTH “**Specifications for Road and Bridge Works**”- 2001, fourth revision, Indian Roads Congress
7. MORD “**Specification for Rural roads**”
8. MORD “**Standard data book for analysis of rates for rural roads**”

**Note:**

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.



## CEH- 578: HIGHWAY SUBGRADE AND FOUNDATION ANALYSIS

<b>L</b>	<b>P</b>	<b>Credits</b>	<b>Class Work</b>	<b>25 Marks</b>
<b>4</b>	<b>0</b>	<b>4</b>	<b>Examinations</b>	<b>75 Marks</b>
			<b>Duration of Exam</b>	<b>3 Hrs</b>

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### UNIT I

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.

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

### UNIT II

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  $\phi$ - $c$  soil, Location of most critical circle, Earth dam slopes stability, Taylor’s stability number. Effect of Earthquake Force, problems on above.

### UNIT III

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.

### UNIT IV

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.

### TEXT/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, 16<sup>th</sup> edition.
3. “Highway Engg”, S.K. Khanna, C.E.G. Justo, 5<sup>th</sup> edition.
4. “Soil Mechanics & Foundation Engg” – K.R. Arora Standard Publishers Distributors.
5. “Soil Mechanics for road Engineers” – HMSO, London.

**Note:**

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CE-580: PROBABILITY AND STATISTICS

L      P      Credits  
4      0      4

Class Work      25 Marks  
Examinations      75 Marks  
Duration of Exam 3 Hrs

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### UNIT I

Probability distributions: Introduction to probability and random variables, Binomial distribution, Poisson distribution, Geometric distribution, Hyper Geometric distribution, Normal distribution, Log-Normal distribution, Uniform distribution.

Exponential distribution, Gamma distribution, Beta distribution, and Weibull distribution. Bi-Variate Normal Distribution And The Associated Marginal And Conditional Distributions

### UNIT II

Parameter Estimation and hypothesis Testing: Random samples, sampling distributions of mean and variance. Point estimators, the method of maximum likelihood, and the method of moments. Confidence interval estimation of  $\mu$  - mean, and variance. Statistical hypothesis tests, Operations characteristic curve.

Tests of hypothesis on the mean of a Normal Distribution, Tests of hypothesis on the means of two Normal distributions, the paired t-test, Tests of hypothesis on one variance, Tests of hypothesis for the equality of two variances, chi square test, The testing of goodness of fit.

### UNIT III

Design and Analysis of Experiments: Fundamental assumptions of analysis of variance, single factor experiments, Latin square and Latin square designs, Design of experiments with several factors- Two factor factorial experiments.

Regression and Correlation Analysis: Estimation and analysis of simple regression models, correlation coefficients, analysis of correlation coefficients, Hypothesis tests associated with regression and correlation coefficients, curvilinear regression models, Multiple regression models, multiple and partial correlation coefficients.

### UNIT VI

Statistical quality control: control charts of all types, ISO 9000 Series And Their Importance, operating characteristic Curves, Advantages And Limitations of standard quality limit

Reliability Theory: Theory of Reliability, Maintainability, Availability, Failure Distribution, State Dependent Systems, Series And Parallel Connections, Redundancy of Systems

#### **Recommended References:**

- 1 Gupta S. P. and Kapoor V. K., Fundamentals of Statistics, Sultan Chand and Sons, Delhi - 02(2005)
- 2 Hines, W. W. and Montgomery, D. C., et. al.; "Probability and Statistics in Engineering and Management Science", John Wiley and Sons, New York, (1990).
- 3 Freund, J. E.; "Mathematical Statistics", PHI, New Delhi, (1990)
- 4 Montgomery, D. C.; "Design and Analysis of Experiments", 5th edition, John Wiley and Sons, INC., New York. (2001).
- 5 Johnston, J. and Dinardo, J.; "Econometric Methods", 4th edition, McGraw-Hill International Editions, (1997).

- 6 Benjamin, J. R. and Cornell, C. A.; "Probability Statistics and Decision for Civil Engineers", McGraw-Hill, (1970).

**Note:**

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CEH- 651: ROAD TRANSPORT REGULATIONS & ADMINISTRATION

<b>L</b>	<b>P</b>	<b>Credits</b>
<b>4</b>	<b>0</b>	<b>4</b>

<b>Class Work</b>	<b>25 Marks</b>
<b>Examinations</b>	<b>75 Marks</b>
<b>Duration of Exam 3 Hrs</b>	

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### UNIT I

**Introduction to Traffic regulations and control** - Regulation on vehicles, drivers and traffic flow, Traffic control devices - Types & objectives of markings, signs, signals and islands, delineators.

Role of M.V. Department in existing road transport scenario in India

### UNIT II

Transportation systems - sustainable transport - mobility, accessibility - safety, environment - revenue generation.

M.V. Act and CMV Rules - Implementation issues thereof, Issues in road enforcement, control of traffic, signage.

### UNIT III

Transportation planning process and demand forecasting, road safety issues, coordination with other agencies, claims & compensation under MV Act.

Issues in insurance of vehicles, licensing of drivers, taxation of vehicles and passengers, permits under MV Act.

### UNIT IV

Inspection/ testing and certification of vehicles. Bus body code & Bus body accreditation system.

Developing customer orientation in M.V. Department functions, RFID based Driving Skill Evaluation system (IDTS)

TEXT/REFERENCE BOOKS:

**Note:**

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CE-653: HIGHWAY DRAINAGE SYSTEMS

<b>L</b>	<b>P</b>	<b>Credits</b>	<b>Class Work</b>	<b>25 Marks</b>
<b>4</b>	<b>0</b>	<b>4</b>	<b>Examinations</b>	<b>75 Marks</b>
			<b>Duration of Exam</b>	<b>3 Hrs</b>

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### UNIT I

Drainage materials. Methods of maintenance of different types of pavements;  
Special problems in high rainfall areas. Frost heave

### UNIT II

Subgrade Drainage and Earthworks Consolidation  
Sub-Base Drainage

### UNIT III

Failure Due To Hydraulic Pressure, Failure Due To Binder Stripping, effect of water table variations  
Drainage of Porous Surface Courses

### UNIT IV

Design procedures and IRC Guidelines for Drainage of Urban Roads and maintenance of drainage system  
Design and construction of surface and sub-surface drainage systems for highways and airports.

#### TEXT/REFERENCE BOOKS:

1. Highway Engineering by Khanna and Justo, Nem Chand & Brothers, Roorkee
2. Highway Engineering by L.R. Kadyali, Nem Chand & Brothers, Roorkee
3. RC SP:42 -1994, "Guidelines on Road Drainage"- Indian Roads Congress
4. Harry.R.Cedergern. "Drainage of Airfield pavements"- John Wiley and Sons.

#### Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CEH- 655: DESIGN AND CONSTRUCTION OF BRIDGES AND FLYOVERS

L	P	Credits	Class Work	25 Marks
4	0	4	Examinations	75 Marks
			Duration of Exam	3 Hrs

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### UNIT I

Introduction–classification and components of bridges– layout and planning– Structural forms of bridge decks – grillage analysis of slab decks, beam and slab decks, and cellular decks. Standard specifications for bridges – IRC loadings for road bridges – standards for railway bridges.

Loads on Bridge: Dead loads, live loads, dynamic effects of vehicles, longitudinal forces, centrifugal forces, wind loads, earth quake forces, stream flow pressure, load combinations, design examples

### UNIT II

Design of T beam bridges – balanced cantilever bridges – rigid frame bridges – Arch bridges – bow string girder bridges.

Design of Bridge Slabs: Longitudinally reinforced deck slabs, transversely reinforced bridge slabs

### UNIT III

Design of plate girder bridges – steel trussed bridges – Introduction to long span bridges: cable stayed bridges and suspension bridges –instability.

Principles of Planning of Elevated Rail Transit System, grade separation structures, pedestrian crossing and sub- ways.

Forces on piers and abutments – Design of piers and abutments – types of wing walls – types of bearings – design of bearings.

### UNIT IV

Design of Prestressed Concrete Bridges: Design code, design examples. Segmental Box bridges - precast sections, criteria, design examples

Sub-Structure Design: Foundation investigation, bearings, bridge pier design, and abutment design. Examples.

### TEXT/REFERENCE BOOKS:

1. Raina, R.K, 'Principles of Design of RCC Bridges, Tata McGraw Hill,1999.
2. N. Krishna Raju, Design of bridges, Oxford & IBH publishing Co. Ltd., New Delhi.
3. D.Johnson Victor, Essentials of bridge engineering, Oxford & IBH publishing Co. Ltd., New Delhi.
4. Jaikrishna and O.P Jain, Plain and reinforced concrete-vol.II, Nem Chnand & Bros,Roorkee.
5. IRC: 5 -1970, Standard specifications and code of practice for road bridges, Sections I to V.
6. Indian railway standard code of practice for the design of steel or wrought iron bridge carrying Rail, road or pedestrian traffic, Govt. of India, Ministry of Railways, 1962.
7. Conrad P. Heins and Richard A. Lawrie, 'Design of Modern Concrete Highway Bridges, John Wiley and Sons,1999.
8. Baidar Bakht and Leslie, G. Jaeger, 'Bridge Analysis Simplified, Mcgraw Hill Book Co,1998.
9. Johnson Victor, 'Bridge Engineering', Oxford IBH, New Delhi,2000.

**Note:**

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.



## CEH-657: ACCIDENT ANALYSIS

<b>L</b>	<b>P</b>	<b>Credits</b>	<b>Class Work</b>	<b>25 Marks</b>
<b>4</b>	<b>0</b>	<b>4</b>	<b>Examinations</b>	<b>75 Marks</b>
			<b>Duration of Exam</b>	<b>3 Hrs</b>

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### UNIT I

Introduction to Road Safety Engineering and Accident Investigation, Factors Relating to Accidents, various forms of recording of accident data, study of IRC recommended recording proforma

### UNIT II

Accident Investigation & Crash Problem Diagnosing: investigation at site, various driver related tests, calculation of post crash speed from skid marks, collision and condition diagrams, and traffic and speed studies.

### UNIT III

Accident Costing, Economic Appraisal: various methods of calculation of accident costs, their advantages and disadvantages, case studies.

### UNIT VI

Crash Problems into Solutions: research and development in accident analysis, issues and challenges in modeling of road accidents, Smeed's model, Base line models, General ADT models, Models with covariates, AMFs, various measures to improve road safety, before and after studies.

### TEXT/REFERENCE BOOKS:

1. Highway Engineering by Khanna and Justo, Nem Chand & Brothers, Roorkee
2. Kadiyali, L.R., 'Traffic Engineering and Transport Planning', Khanna Publications.
3. Pignataro, Louis, 'Traffic Engineering - Theory and Practice', John Wiley.
4. RRL, DSIR, 'Research on Road Safety', HMSO, London.
5. Papacoastas '**Introduction to Transportation Engineering**' -Prentice

### Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

## CEH- 659 : ROAD SAFETY AND CORRIDOR MANAGEMENT

L	P	Credits	Class Work	25 Marks
4	0	4	Examinations	75 Marks
			Duration of Exam	3 Hrs

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### UNIT I

**Congestion:** Management of congested facilities, Expressway and surface streets, types of congestion, key issues in Expressway congestion, congestion issues related to the surface street system, administrative and planning actions, techniques for addressing Expressway system congestion, congestion due to a bottleneck, cumulative demand and capacity, signal remedies in addressing surface street congestion, Expressway surveillance and control.

### UNIT II

**Introduction to Expressway Systems:** Expressway as part of highway system, operations and design features of Expressway, capacity analysis of basic freeway sections, capacity analysis of Expressway weaving sections, capacity analysis of ramps and ramp junctions, calibrating relationships for freeway analysis. Non access controlled multilane Highways.

### UNIT III

**Expressway Corridor Management:** Management strategies, Components of corridor management, Surveillance and control, Corridor Signage, Building Construction and Land Use, Entrances to Provincial Highways, Encroachments on the Right-of-Way, high occupancy vehicle facilities and incentives, enforcement and control, traffic restrictions, organisational structure, policies and procedure for effective corridor management.

### UNIT IV

**Intelligent Vehicle Highway Systems:** Introduction, IVHS programs, role of IVHS in transportation systems of tomorrow, IVHS categories, benefits and costs of IVHS, institutional issues, key considerations. Safety management systems.

#### TEXT/REFERENCE BOOKS:

1. Papacostas, C.A., 'Fundamentals of Transportation Engineering', Prentice-Hall of India Private Limited, New Delhi.2000.
2. William R. McShane and Roger P. Roess,, 'Traffic Engineering', Prentice hall, New Jersey.2000.
3. Institute of Transportation Engineers, 'Traffic Engineering Hand Book', Prentice Hall, New Jersey,1985.
4. Ogden K.W "Safer Roads - A Guide to Road Safety Engineering', Avebury Technical, Aldershot . UK.1990.
5. MOST, 'Manual For Safety in Road Design', Ministry of Surface Transport. Govt. of India.
6. Ballou, R.H., "Business Logistics Management", 4th Edition, Prentice Hall
7. Murphy, G.J. "Transport and Distribution", 2nd Edition, Business Books

**Note:**

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit. The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.