



**Government of Karnataka**

**DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION**

<b>Programme</b>	<b>Civil Engineering</b>	<b>Semester</b>	<b>V</b>
<b>Course Code</b>	<b>20CE53I</b>	<b>Type of Course</b>	<b>Specialization Pathway</b>
<b>Course Name</b>	<b>Transportation Engineering</b>	<b>Contact Hours</b>	<b>36 hours per week</b>
<b>L:T:P</b>	<b>104 : 52 : 312</b>	<b>Credits</b>	<b>24</b>
<b>CIE Marks</b>	<b>240</b>	<b>SEE Marks</b>	<b>160</b>

**Introduction:** Welcome to the curriculum for Transportation Engineering Specialization. This specialization course is taught in Boot camp mode. Boot camps are 12 weeks, intense learning sessions designed to prepare you for the practical world – ready for either industry or becoming an entrepreneur. You will be assisted through the course, with development-based assessments to enable progressive learning. In this course, you'll learn to investigate, plan, analyze, design, execute, and maintain Transportation systems.

Leading to the successful completion of this boot camp, you shall be equipped to either do an internship at an organization working in Transportation Engineering related industry or do a project on Transportation Engineering.

After the completion of your Diploma, you shall be ready to take up roles like Junior Engineer, Transport Planning Data Surveyor, Designer, Entrepreneur, Consultant, Contractor, Road Safety Auditor or can work or have your own Consultancy Services for Material Testing, Planning, Construction and Management of Transportation facility.

This course will teach you Fundamentals of data collection, data analysis, forecasting, design, drafting, evaluation, estimating and costing, Construction, management and maintenance of different components of Transportation System. Details of the curriculum is presented in the sections below.

Transportation engineering is the application of technology and scientific principles to the planning, functional design, construction, operation, maintenance and management of facilities for any mode of transportation in order to provide safe, efficient, rapid, comfortable, convenient, economical, and environmentally compatible movement of people and goods with respect to time and space.

The facilities support Surface ( Road and Railways), air and water transportation. The design aspects of transportation engineering include the sizing of transportation facilities how many lanes or how much capacity the facility has, determining the materials and thickness used in pavement, designing the geometry (vertical and horizontal alignment) of the roadway or track. Operations and management involve traffic engineering, so that vehicles move smoothly on the road or track, transportation Structures like Bridges, Tunnels, Retaining Walls, Flyover and Underpasses. Transportation engineering emphasizes on Road safety and assess environmental and health impacts.

### **Pre-requisites:**

Before the start of this specialization course, you would have completed the following courses;

In the 1st year of study, you would have studied Engineering Mathematics, Communication Skills, Civil Engineering Graphics, Statistics & Analysis, Basic IT Skills, Basic Surveying, Fundamentals of Electrical and Electronics Engineering, Project Management skills, Construction Materials, Environmental Sustainability.

In the 2nd year of study, you would have studied Engineering Mechanics and Strength of Materials, Modern Surveying, Construction Techniques, Building Drawing using CADD, Concrete Technology, Building Estimating and valuation, Site Management, Design and detailing of RCC structures.

In this year of study, you shall be applying your previous years learning along with specialized field of study into projects and real-world applications.

### **Instruction to course coordinator:**

1. Each Pathway is restricted to a Cohort of 20 students which could include students from other relevant programs.
2. Single faculty shall be the Cohort Owner.
3. This course shall be delivered in boot camp mode.
4. The industry session shall be addressed (in contact mode/online / recorded video mode) by industry experts only.
5. The cohort owner shall identify experts from the relevant field and organize industry sessions as per schedule.
6. Cohort owner shall plan and accompany the cohort for industrial visits.
7. Cohort owners shall maintain and document the industrial assignments and weekly assessments, practices and mini projects.
8. The cohort owner shall coordinate with faculties across programs needed for their course to ensure seamless delivery as per time table.

9. The cohort owner along with the classroom can augment or use for supplementally teaching online courses available although reliable and good quality online platforms like Karnataka LMS, Infosys Springboard, NPTEL, Unacademy, SWAYAM, etc.
10. Cohort owner shall guide the cohorts for the execution of mini project.

**Course outcome: At the end of the semester students will be able to,**

CO1	Conduct Surveys to fix the alignment of the road and prepare Geometric design required for the alignment of road construction and study the traffic flow and behavior of vehicular movement at intersection, traffic engineering characteristics, regulations and control which helps to collect various traffic data and conduct accident analysis
CO2	Investigate Soil and pavement materials , Prepare Alignment Drawings, Pavement design and select suitable equipment/ machinery and Suggest suitable pavement construction methodology for road construction and take required safety precautions during road construction
CO3	Design suitable surface drainage system for road construction Estimate the road works to determine construction, operation and annual cost and suggest suitable soil stabilization technique and recommend suitable repairs technique with regular maintenance skills having a knowledge of highway financing
CO4	Compare between different types of railway systems with Local Bus transport system and differentiate between different modes of transportation system( surface, water and air) and suggest suitable transportation structure for the transportation project
CO5	Conduct road safety auditing and Assess environmental and health impact and Select the appropriate tools, production environment and deploy the model.



### Detailed course plan

Wee k	C O	P O	Day s	1 <sup>st</sup> session (9am to 1 pm)	L	T	P	2 <sup>nd</sup> session (1.30pm to 4.30pm)	L	T	P
1	1	1,2	1	<b>Audio-Visual Presentation on</b>  <b>Introduction to Specialization :</b> Importance of transportation Engineering, Role of Transportation in national development- Economic, Social, Spatial, Cultural and Political Development  <b>Road Transportation – Surface Transportation</b>  1. Formation of Jayakar Committee and its recommendations and Implementations  2. Importance of Indian Road Congress (IRC) Committees and Sub committees, Importance of IRC Codal Provisions  3. Characteristics of Road Transportation , Saturation system, its advantages and limitations  <b>Case Exercise ( Tutorial)</b> <ul style="list-style-type: none"> <li>Study and prepare report on Ongoing National Level highway Development Plan (NHDP) and Improvement of</li> </ul>	3		1	<b>Audio-Visual Presentation on</b>  1. Highway alignment, Major ideal requirements of highway alignment  2. Factors affecting Highway alignment, Steps to be followed in new highway alignment  3. Engineering Surveys for New highway alignment, Drawings and Report  4. Phases of New Highway Project  <b>Case Exercise ( Tutorial)</b> <ul style="list-style-type: none"> <li>Study Different Class of roads- National Highway (NH), State Highway(SH), Major District Roads(MDR), Other District Roads(ODR) and Village roads(VR)</li> <li>Study on detailed report preparation of New Highway Project ( Real Time Project Report)</li> </ul>	2	1	

				Riding Quality Programme(IRQP)						
				<ul style="list-style-type: none"> <li>Study and prepare report on Present Scenario of Road Development in India</li> </ul>						
1	1,2	2		<b>Audio-Visual Presentation on</b> <ol style="list-style-type: none"> <li>1. Realignment of highways, Objectives of Realignment, Steps to be followed in highway realignment</li> <li>2. Study of Different Road Patterns- Rectangular , Radial or Star and Block , Radial or Star and Circular, Hexagonal Pattern</li> <li>3. Importance of Curves in Road and Railway alignment, Curves- Elements of Curves, relation between Radius and Degree of a curve</li> <li>4. Types of curves – Horizontal and vertical curves.</li> </ol>	2	2	<ol style="list-style-type: none"> <li>1. Elements of Horizontal Curves- <ul style="list-style-type: none"> <li>• Simple Curve</li> <li>• Compound Curve</li> <li>• Reverse Curve</li> <li>• Transition curves</li> </ul> </li> <li>2. Procedure for Setting out Simple curve by Rankine's method using Total Station ( Deflection Angle Method)</li> <li>3. Procedure for Setting out Compound curve by Rankine's method using Total Station (Deflection Angle Method)</li> <li>4. Procedure for Setting out Reverse Curve between Two Parallel Lines using Total Station (Deflection Angle Method)</li> </ol>			3
1	3	3		<b>Field Practice</b> <ol style="list-style-type: none"> <li>1. Set out simple curve by Rankine's method using Total Station in field</li> </ol>		4	<b>Audio-Visual Presentation on Geometric Design – IRC 38</b> <ol style="list-style-type: none"> <li>1. Importance of highway geometrics</li> <li>2. <b>Geometric Design Control and Criteria:</b> Design Speed, Topography or terrain, Traffic factors, Design</li> </ol>			3

			2. Set out Compound curve by Rankine's method using Total Station in field  3. Set out Reverse Curve between Two Parallel Lines by Deflection Angle Method using Total Station in field			hourly Volume and Capacity, Environmental and other factors  3. <b>Highway Cross Section Characteristics</b> : Pavement Surface Characteristics, Friction, Pavement unevenness, Light Reflecting Characteristics			
1	4	4	<b>Audio-Visual Presentation on</b>  1. <b>Cross Sectional elements</b> – Cross slope or Camber, Width of carriage way, Medians, Kerb  2. Road Margins : Shoulders, guard rail, Foot path, drive way, cycle track, parking lane, bus bay, frontage roads and embankment slopes, cut slopes  3. Right of Way or Width of Formation: Factors affecting Right of way  <b>Case Exercise:</b> Refer the following 1. IRC recommendations of Right of Way Width for different types of roads 2. IRC 38 - Guidelines for Design of Horizontal Curves for Highways and Design Tables	1	3	1. Drawing and detailing of typical Cross section of roads <ul style="list-style-type: none"> <li>• Cross Section in Embankment</li> <li>• Cross Section in Cutting</li> <li>• Cross section of VR or ODR in embankment in rural area</li> <li>• Cross section of MDR in cutting in Rural area</li> <li>• Cross section of two lanes in city in Urban area</li> </ul> <b>Audio-Visual Presentation on</b> 1. <b>Types of Sight Distance:</b> <ul style="list-style-type: none"> <li>• Stopping Sight Distance(SSD)</li> <li>• Over Taking distance(OSD),</li> <li>• Sight Distance at Intersections</li> <li>• Intermediate Sight Distance(ISD)</li> <li>• Head Light sight distance(HSD) for night driving</li> </ul>			3
1		5	<b>Developmental Assessment</b>			Assessment Review and corrective action			3
1	7	6	Industry Session:	1	4	Industry assignment			

				1.Importance and Applications of transportation engineering studies in Industry  3. Establish link between Transport Planning, Traffic studies, Designs , Material Testing for Quality Control, Construction and Maintenance of Transportation system  4. Phases of Highway Project and its Report Preparation						
2	1	3,7	1	1. Peer review on industry class.  2. Review of Case exercises  3. Refer Law resources IRC codal Provisions : <a href="https://law.resource.org/pub/in/bis/irc">https://law.resource.org/pub/in/bis/irc</a>	4		<b>Audio-Visual Presentation on</b>  1.Factors affecting SSD and OSD, Standard values of SSD and OSD for different design speed as per IRC ,Expressions for calculating SSD , ISD, HSD, OSD, Overtaking zones  2.Elements of Horizontal Alignment – Objectives and Expressions for the following <ul style="list-style-type: none"> <li>• Design speed</li> <li>• Type of Curve provided</li> <li>• Super elevation</li> <li>• Extra width at curve</li> <li>• Setback distances and Curve resistance</li> </ul>			3
	1	3	2	1.Numerical problems on the following <ul style="list-style-type: none"> <li>• Cross sectional elements</li> <li>• Types of sight distances</li> <li>• Design of elements of horizontal alignment</li> </ul>	1	3	<b>Types of Vertical curves:</b> Summit Curves or crest curves, Valley curves or Sag curves  1. Length of Summit curves and Valley curves, and its expressions 2. Design criteria for summit curve and Valley curves	1		2

			<b>2. Audio-Visual Presentation on Vertical alignment-</b> 1. Types of gradient : Ruling gradient, Limiting gradient, Exceptional gradient and minimum gradient 2. Grade Compensation at curves			3. Numerical Problems on design of elements of Vertical alignment Reference : IRC SP 23			
1	3	3	<b>Audio – Visual Presentation on Traffic Engineering</b> <ul style="list-style-type: none"> <li>• Introduction to Scope of Traffic Engineering</li> <li>• Road User characteristics</li> <li>• Vehicular characteristics</li> <li>• Fundamental Parameters and Relations of Traffic Flow (Q), Density (K) and Speed (V), Travel Time.</li> <li>• Spot speed, Time Mean Speed, Space mean speed, Time headway and Distance headway</li> <li>• Simple numerical problems</li> </ul>	1	3	<b>Audio – Visual Presentation on Traffic Engineering Studies</b> <b>1. Traffic Volume Characteristics</b> <ul style="list-style-type: none"> <li>• Traffic Flow- PCU, PHF, PCU values recommended by IRC</li> <li>• Traffic Volume studies and Pedestrian Volume studies</li> <li>• Manual and Automatic traffic volume counting methods</li> <li>• Measurement and analysis of Traffic Volume data- AADT, ADT, AAWT, AWT</li> <li>• Simple Numerical Problems on Peak hour Volume and Peak hour factor using PCU values</li> </ul> <b>2. Spot Speed studies</b> <ul style="list-style-type: none"> <li>• Uses and factors affecting spot speed studies</li> <li>• Measurement of spot speed study-               <ul style="list-style-type: none"> <li>a) Stopwatch method</li> <li>b) Radar meter method</li> </ul> </li> </ul>	1	2	



							c) Pneumatic road tube method <ul style="list-style-type: none"> <li>Frequency Distribution diagram of Spot speed from data</li> <li>Simple Numerical Problems</li> </ul>		
1	3	4	<b>Audio – Visual Presentation on</b> <b>3.Speed and Delay studies</b> <ul style="list-style-type: none"> <li>Objects and uses of speed and delay studies</li> <li>Methods of conducting Speed and delay studies               <ol style="list-style-type: none"> <li>Floating car / moving observer method.</li> <li>License plate method</li> <li>Interview technique</li> <li>Elevated Observations</li> <li>Photographic technique</li> </ol> </li> <li>Simple numerical problems on Determination of Flow, Density and Speed using Moving observer method</li> </ul> <b>4.Origin and Destination Studies</b> <ul style="list-style-type: none"> <li>Objects, types and applications of Origin and Destination studies</li> <li>Methods of conducting Origin and Destination studies- data collection               <ol style="list-style-type: none"> <li>Home Interview method</li> <li>Road side Interview method</li> <li>License plate method</li> </ol> </li> </ul>	1	3	<b>Audio – Visual Presentation on</b> <b>5.Parking studies</b> <ul style="list-style-type: none"> <li>Need and effect of parking</li> <li>Investigations for parking studies</li> <li>Parking characteristics</li> <li>Parking demand</li> <li>Method to determine parking demand</li> </ul> <b>6.Accident Studies</b> <ul style="list-style-type: none"> <li>Importance of accident studies</li> <li>Causes of accidents</li> <li>Collection of accident data, report and records</li> <li>Accident Investigations</li> <li>Accidental analysis</li> <li>Measures of reduction of accident rate               <ol style="list-style-type: none"> <li>Engineering</li> <li>Enforcement</li> <li>Education</li> </ol> </li> <li>Simple problems on accidental analysis</li> </ul> <b>Case exercise(Tutorial)</b>	1	2	

				d) Return post card method e) Tag on vehicle method • Sampling in O-D studies			1. Study real time Accidental investigation and analysis report to understand the methods and steps followed and measures suggested to reduce the accident			
	1		5	<b>Developmental Assessment</b>			Assessment Review and corrective action			3
	1	7	6	<i>Industry session-</i> Introduction to highway geometric design softwares and its application  • <b>MX ROAD</b> • <b>CIVIL 3D</b>	1	4	<i>Weekly industry assignment.</i>			
3	1	1	1	1. Peer review on industry class. 2. Review of Case exercises		4	<b>Audio Visual presentation on Capacity and Level of Service</b>  • Factors affecting level of service • Design Capacity and design service volumes for different capacity roads  <b>Inventory of Transport Facilities</b>  • Inventory of Streets • Traffic Volume • Travel Time Studies • Inventory of Public Transport Buses • Inventory of Rail Transport Facilities • Parking Inventory • Accident Data	1		2

							<ul style="list-style-type: none"> <li>Land Use and Economic Activities</li> </ul>			
							<b>Case exercise(Tutorial)</b> <ol style="list-style-type: none"> <li>1. Prepare a presentation on Traffic Regulations and Control measures</li> <li>2. Economic loss caused by Inferior traffic facilities</li> </ol>			
1	4	2	<b>Project 1: Traffic Engineering</b>							21
		3	<b>Field survey :</b> Conduct the following surveys and collect data in a given area on selected stretch of major road to determine the Level of Service of that road as per IRC standards							
		4	<ol style="list-style-type: none"> <li>1. Traffic Volume and composition study by Manual counting method</li> <li>2. Spot speed study by manual method</li> <li>3. Origin and Destination survey of an area by Home Interview survey and Road side Interview survey</li> <li>4. Parking Vehicle Compositions</li> </ol>							
			<b>Graded Exercise and Report</b> <ol style="list-style-type: none"> <li>1. Classified traffic Volume count by converting count into PCU values using tables</li> <li>2. Representation of traffic composition using tables and charts ( Pie charts/ Bar charts)</li> <li>3. Representation of spot speed of vehicles in frequency distribution diagram using tables and charts (Line chart)</li> <li>4. Representation of Parking vehicle composition using tables and charts ( Pie chart / Bard chart)</li> <li>5. Home interview and road side interview data on O-D study using standard formats and tables</li> <li>6. Collection of accidental data of that selected major road of a given area from relevant sources and prepare Vehicle interference diagram related to accident analysis</li> <li>7. Determination Level of Service of the given road as per IRC standards based on data</li> <li>8. Representation of Projected yearly traffic growth using bar chart</li> </ol>							
		5	<b>CIE 1- Written and practice test</b>				Assessment Review and corrective action			3
1	4	6	<i>Industry class- -</i>			1	4	<i>Weekly industry assignment.</i>		

				1 Introduction to Traffic study and simulation softwares and its application  • <b>DATA FROM SKY</b> • <b>VISSIM</b>						
4	2	4	1	1. Peer review on industry class 2. Presentation by students on Traffic Regulations and Control measures		4	<b>Types of Pavements- Audio Visual Presentation</b>  1. Need for highway pavement 2. Structure of flexible pavement and Rigid Pavement 3. Functions of flexible and rigid pavements 4. Basic Difference between rigid and flexible pavement 5. Advantages of flexible and Rigid pavements 6. Limitations of flexible and Rigid pavements	2		1
	2	4	2	<b>Audio-Visual Presentation on FLEXIBLE PAVEMENT</b>  1. Flexible Pavement layers – Subgrade, Sub base, Base course, Surface course, Wearing course and its functions  2. Soil as Subgrade layer - Application of Soil Mechanics in Road Construction	2	2	<b>1. Laboratory procedure to determine following Index properties :</b>  • Water content • Specific gravity • Particle Size distribution • Consistency limits • Insitu Density  <b>2. Soil Classification Systems:</b> IS classification system and AASHTO classification  3. Numericals on determining index properties	1		2



			<p>3. Three Phase system of Soil, Water Content, Density, Unit weights, Specific Gravity, Void Ratio, Porosity and Degree of Saturation, its functional relationships</p> <p>4. Introduction to Index properties and engineering properties of soil.</p>			4.Numerical on Soil Classification by IS system and HRB systems		
2	4	3	<p><b>LAB EXPERIMENTS</b></p> <p>1. Conduction of experiment to determine water content in the given sample of soil by oven drying method and Pycnometer method</p> <p>2. Conduction of experiment to determine Specific Gravity in the given sample of soil</p> <p>3. Conduction of experiment to determine Particle Size Distribution in the given sample of soil by Dry Sieve analysis</p>		4	<p><b>LAB EXPERIMENTS</b></p> <p>1. Conduction of experiment to determine liquid limit by Casagrande's apparatus</p> <p>2. Conduction of experiment to determine Plastic limit by method of rolling</p> <p>3. Conduction of field experiment on determination of In-situ Density of soil by Core Cutter method / sand replacement method</p> <p><b>Case Exercise :</b> Importance of soil testing for Index properties in determining type and behavior of soil for road construction</p>		3
2	4	4	<p><b>Audio Visual Presentation</b></p> <p>1. Importance and factors affecting the Engineering properties of soil : Shear</p>	1	3	<p><b>LAB EXPERIMENTS</b></p> <p>1.Conduction of Dynamic Compaction test for the given sample of soil by Modified Proctor test method</p>		3

				strength , Compaction and Permeability of soil 2. Procedure for determining the Optimum moisture content and Maximum Dry density of Soil by Modified Proctor Compaction test 3.Procedure for determining Strength of soil by California Bearing Ratio test (CBR)			2. Conduction of CBR test for the given sample of soil 3.Laboratory Experiments on Soil - Review of results and corrective action <b>Case Exercise :</b> Importance of soil testing for Engineering properties in determining type and behavior of soil for road construction			
	2		5	<b>Developmental Assessment</b>			Assessment Review and corrective action			3
	2	4	6	<i>Industry class – Consultancy Services</i> 1.Soil Testing 2. Swelling Index Test of Soil – Importance and test procedure	1	4	<i>Weekly industry assignment.</i>			
5	2	2,3	1	1. Peer review on industry class 2. Review of Case exercises 3. Review of <b>Project 1</b>			<b>Introduction to Pavement Materials: Aggregates</b> 1. Origin, Classification and Properties of aggregates to be considered for road construction 2. Laboratory Test procedure on aggregate to be considered for road construction as per IS codes and MORTH specifications <ul style="list-style-type: none"> <li>• Impact test</li> <li>• Abrasion test</li> <li>• Polished stone Value test( Only for Demonstration)</li> <li>• Crushing test</li> </ul>	1		2

							<ul style="list-style-type: none"> <li>• Flakiness and Elongation Index test and angularity Number</li> <li>• Specific gravity and Water Absorption test</li> </ul>			
2	4,5	2	<b>LAB EXPERIMENTS</b> <ol style="list-style-type: none"> <li>1. Conduction of Experiment for determining the toughness / resistance to Impact of aggregates by Aggregate Impact Test</li> <li>2. Conduction of Experiment for determining the Hardness / Resistance to Abrasion of aggregates by Los Angeles Abrasion test</li> <li>3. Conduction of Experiment for determining the resistance to crushing of aggregates by Aggregate Crushing Test</li> </ol>		4	<b>LAB EXPERIMENTS</b> <ol style="list-style-type: none"> <li>1. Conduction of Experiment for determine the Specific Gravity and Water absorption of aggregates</li> <li>2. Conduction of Experiment for determining the shape of aggregates by Flakiness and Elongation test</li> <li>3. Conduction of Experiment for determining the shape of aggregates by Angularity Number</li> </ol> <p><b>Case Exercise :</b></p> <p>Study MORTH Specifications on the results of each tests for inference of its application in road construction</p>			3	
2	4,5	3	<b>Introduction to Pavement Materials-Binder</b> Audio – Visual Presentation <ol style="list-style-type: none"> <li>1. Origin of Asphalt ,Bitumen and Tar and its types</li> <li>2. Chemical Composition of Bitumen and Tar, Differences between Bitumen and Tar and its grades</li> </ol>	2	2	<ol style="list-style-type: none"> <li>1. Functions of binder as Pavement Material and desirable properties</li> <li>2. Laboratory Test procedure on bitumen to be considered for road construction as per IS codes and MORTH specifications               <ul style="list-style-type: none"> <li>• Penetration test</li> <li>• Ductility test</li> <li>• Softening point test</li> <li>• Specific gravity test</li> </ul> </li> </ol>	1		2	

			3. Introduction and Applications of following bitumen used in road Construction			<ul style="list-style-type: none"> <li>• Viscosity test</li> <li>• Flash and Fire point test</li> <li>• Float test</li> <li>• Water content test</li> <li>• Loss on heating test</li> <li>• Stripping Value test ( Adhesion between Bitumen- aggregate )</li> </ul>			
2	3,4,5	4	<b>LAB EXPERIMENTS</b> <ol style="list-style-type: none"> <li>1. Conduction of Experiment for determining the consistency of bituminous material by Penetration test</li> <li>2. Conduction of Experiment for determining the Ductility or malleability of bituminous material by Ductility test</li> <li>3. Conduction of Experiment for determining the Temperature at which bituminous material softens by Softening point test</li> <li>4. Conduction of Experiment for determining the Specific Gravity of bituminous material softens by Pycnometer Method</li> </ol>		4	<b>LAB EXPERIMENTS</b> <ol style="list-style-type: none"> <li>1. Conduction of Experiment to determine the rate of flow of bituminous material by viscosity test using Orifice Viscometer</li> <li>2. Conduction of Experiment for determining the Temperature at which bituminous material catches flash and fire ( Safety)by Flash and Fire Point Test</li> <li>3. Conduction of Experiment for determining the adhesion of bituminous material on the surface of aggregate by Stripping value test of aggregates</li> </ol> <p><b>Case exercise :</b> IRC and MORTH Specifications on the results of each tests for inference of its application in road construction</p>			3
		5	<b>CIE 2- Written and practice test</b>			Assessment Review and corrective action Laboratory tests on pavement material-Soil,			3



							Aggregate and Bitumen - Review of results and corrective action			
	2	4,5	6	<i>Industry class-</i> 1. Consultancy Services – Pavement Material Testing 2. Partial Replacement of pavement materials with recycled materials / sustainable materials in pavement construction	1	4	Industry weekly assignment			
6	2	1,3	1	1. Peer review on industry class 2. Review of Case exercises		4	<b>Bituminous Paving mix :</b> 1. Gradation and proportioning of aggregates by Rothfutch method 2. Step wise Procedure for preparation of Bituminous trial mix 3. Procedure to determine the Stability, Flow Value and Optimum Binder Content of Bitumen trial mix by Marshal Stability test 4. Demonstration of the experiment to check the Marshal Stability for the Bituminous mix prepared from Mix design	1		2
	2	2,3	2	<b>Audio-Visual Presentation on RIGID PAVEMENT</b> 1. Components of Cement Concrete Pavements and their functions 2. Rigid Pavement Layers- Subgrade, Granular sub base/ Drainage layer, Dry Lean Concrete sub base, Pavement Quality Concrete Slab and its functions	2	2	1. Prepare Dry Lean Concrete (DLC) and Pavement Quality Concrete (PQC) mix design for Pavement as per IS standards 2. Conduct experiment to determine the Compressive and Flexural strength of concrete mix prepared from the mix design as per IRC 44 2017			3

			<p>3. Material Specifications for the construction of Cement Concrete Pavements- Cement, Coarse aggregates, Fine aggregates, Water and admixtures</p> <p>4. Requirements of Paving Concrete</p> <p>5. Different Types of Joints and their functions in Cement Concrete pavements</p>						
2	2,3	3	<p><b>Design of Flexible Pavement: (IRC 37 2018)</b></p> <p>1. Functional and Structural requirements of road pavements</p> <p>2. Factors governing the design of flexible pavement</p> <ul style="list-style-type: none"> <li>• Wheel loads of heavy vehicles or traffic loads and contact pressure- ESWL</li> <li>• Sub grade soil</li> <li>• Climatic factors</li> <li>• Pavement Component material</li> <li>• Environmental Factors</li> <li>• Special factors in the design of different types of pavements</li> </ul> <p>3. Design approach and criteria</p> <ul style="list-style-type: none"> <li>• Estimation of design traffic</li> <li>• Design life</li> <li>• Vehicle Damage Factor (VDF)</li> <li>• Distribution of Commercial Vehicle Traffic</li> </ul>	1	3	<p>1. Stresses and deflection in flexible pavements and its expressions</p> <p>2. Numerical problems on determination of design factors ESWL and VDF</p> <p>3. Numerical problems on IRC method of Design of Flexible Pavement</p>			3

			<ul style="list-style-type: none"> <li>Growth rate</li> </ul>						
2	2,3	4	<b>Design of Rigid Pavement: IRC 58 2015</b>  1.Factors governing the design of rigid pavement and its Standard values and expressions as per <ul style="list-style-type: none"> <li>Wheel load</li> <li>Temperature differential</li> <li>Types of Joints and their spacing</li> <li>Characteristics of Subgrade and Sub base</li> <li>Drainage layer</li> </ul> 2. Characteristic strength and Fatigue behavior of Concrete  3.Stresses in Rigid Pavements and its analysis	1	3	1. Numerical problems on determination of design factors like design loads 2. Numerical problems on IRC method of Design of Rigid Pavement			3
		5	<b>Developmental Assessment</b>			Assessment Review and corrective action			3
2	2,5	6	<i>Industry Class- Special types of pavements</i>  <i>Example :</i> <ul style="list-style-type: none"> <li><i>Semi Rigid pavements</i></li> <li><i>Composite Pavements</i></li> <li><i>Interlocking Cement Block Pavements</i></li> <li><i>Continuously reinforced concrete pavements</i></li> </ul>	1	4	<i>Industry weekly assignment</i>			

				<ul style="list-style-type: none"><li>Steel fiber reinforced concrete pavements</li></ul>						
7	2	2,5	1	Peer review on industry class		4	<b>Flexible Pavement Construction: Audio – Visual Presentation as per MORTH Specifications</b>  1.Introduction , Components of Highway in embankment and cutting  2.Embankment and Subgrade: Functions and Design elements of highway Embankment and Subgrade  3. Construction methodology of highway embankment and Subgrade- Material Specifications, Construction Methodology and Quality Control checks  4. Compaction of soil for the construction of Embankment and Subgrade  <b>Case Exercise ( Tutorial) :</b>  Equipments ,Machineries and Rollers used for Compacting soils and Excavation of earth for road construction			3
	2	7	2	<b>Construction of Flexible Pavement: Audio – Visual Presentation</b>  1. Material Specifications, Construction Methodology and Quality Control checks for the following Components of flexible pavement	1	3	<b>Construction of Flexible Pavement: Audio – Visual Presentation</b>  1. Material Specifications, Construction Methodology and Quality Control checks for the following Components of flexible pavements <ul style="list-style-type: none"><li>Prime Coat and Tack coat</li></ul>	1		2



			<ul style="list-style-type: none"> <li>Granular sub base drainage layer</li> <li>Granular Base course               <ol style="list-style-type: none"> <li>Wet Mix Macadam(WMM)</li> <li>Water Bound Macadam(WBM)</li> </ol> </li> </ul>			<ul style="list-style-type: none"> <li>Bitumen Base Course-               <ol style="list-style-type: none"> <li>Bituminous Macadam (BM)</li> <li>Bituminous Penetration Macadam(BPM)</li> <li>Built-up Spray Grout(BUSG)</li> </ol> </li> </ul>			
2	7	3	<b>Construction of Rigid Pavement: Audio – Visual Presentation</b>  1. Material Specifications, Construction Methodology and Quality Control checks for the following Components of flexible pavements <ul style="list-style-type: none"> <li>Bitumen Surface Course</li> <li>Dense Graded Bituminous Mixes</li> <li>Bitumen Mastic Wearing course</li> <li>Stone Mastic Asphalt (SMA)</li> </ul> <b>Case Exercise :</b> Bitumen Paver Machines and Equipments used in road construction	1	3	<b>Audio – Visual Presentation on Construction of Rigid Pavement</b>  1. Material Specifications, Construction Methodology and Quality Control checks for the following Components of flexible pavements <ul style="list-style-type: none"> <li>Subgrade and Drainage layer</li> <li>Dry Lean Concrete sub base Layer</li> <li>Separation membrane</li> <li>Pavement Quality Concrete pavement slab</li> <li>Construction of joints in rigid pavements</li> </ul> <b>Case Exercise :</b> Machines and Equipments used in rigid pavement construction	1		2
3	7	4	<b>Audio – Visual Presentation Introduction to Road Drainage works- IRC –SP- 42</b>  1. Objectives of road drainage 2. Requirement of highway drainage 3. Types of drainage system <ol style="list-style-type: none"> <li>Surface drainage system</li> </ol>	1	3	1. Standard values and expressions as per IRC 2. Numerical Problems on Design of Surface drainage for roads  <b>Low Volume Roads</b> <ul style="list-style-type: none"> <li>General features of low volume roads</li> <li>Construction of Earthen roads</li> <li>Construction of Gravel roads</li> </ul>	1		2

				b) Sub surface drainage systems c) Cross drainage system 4. Design procedure of surface drainage			<ul style="list-style-type: none"> <li>Construction of Surface roads</li> <li>Construction of Low Volume CC roads</li> </ul>			
			5	<b>CIE 3- Written and practice test</b>			Assessment Review and corrective action			3
	3	7	6	<i>Industry Class</i> 1.Subgrade Soil Stabilization techniques and its importance 2. Pavement Repairs 3.Pavement Maintenance 4.Highway Finance	1	4	<i>Industry weekly assignment</i>			
8	3	1,2	1	1. Peer review on industry class- 2.Review of Case Exercises 3.Progress review of <b>Project 1</b>		4	<b>ESTIMATION OF ROAD WORKS</b> Detailed Estimates and Abstract of Cost of Road work. 1. Compute earth work quantities from given cross sectional details. 2. Preparation of Detailed Estimates and Abstract of Cost of Bituminous & concrete Roads 3. Numerical Problems on Estimation of Operational Cost of highway project 4. Numerical Problems on Estimation of Annual cost of Highway project			3
	2	1,2	2	<b>Project 2 : Pavement Construction Site visit</b>						

	2	7	3	<ul style="list-style-type: none"> <li>Observe and Study about Constructional aspects and methodology for sub grade, sub base, base, bituminous coarse / concrete pavements</li> <li>Observe and Study different types of Equipments, Machineries and Rollers used</li> <li>Observe and Study the Safety precautions taken during Pavement Construction</li> <li>Collect the data about Project details like Type of Soil and its investigations, Pavement materials used and tests conducted, Preparation of pavement layers, setting / curing period and special techniques and latest technologies if any</li> <li>Preparation of Report on Site visit</li> </ul>			14
	3	7	4	<b>Assignment 1:</b> Conduct a site visit to make the students to observe the highway maintenance works and prepare a report <ul style="list-style-type: none"> <li>To check the riding quality of all types of pavement surfaces represented in terms of unevenness index using response type road roughness measuring equipment like Bump Integrator or any other approved equipment</li> <li>To conduct structural evaluation of flexible pavements by Benkelman Beam Deflection method</li> </ul>			7
			5	<b>Developmental assessment</b>		Assessment Review and corrective action	3
	2	7	6	<i>Industry Class-</i> Introduction to PAVEMENT DESIGN and EVALUATION Softwares and its application 1.PAVEMENT DESIGN- <ul style="list-style-type: none"> <li>KENPAVE</li> <li>IITPAVE</li> </ul> 2.PAVEMENT DESIGN AND EVALUATION <ul style="list-style-type: none"> <li>KJPBACK</li> </ul>	1	4	<i>Industry weekly assignment</i>
9	1,2,3	7	1	1. Peer review on industry class 2.Progress review of Project 2 and assignment 1		4	<b>Project 3 :</b> <b>Proposal of New Highway Alignment Project – Survey, Drawings and Report</b>

1,2 ,3	7	2	<p><b>Project 3</b></p> <p><b>1. Traffic Survey-</b> Data Collection – Conduct House Hold Interview Survey in nearby area to determine traffic volume on the proposed road</p> <p><b>2.Field Survey</b> - Terrain to be chosen for survey such that it should include vertical &amp; Horizontal curve – Conduct Survey using Modern Equipments like <b>Total Station</b></p> <p>Align a new road between two obligatory points.</p> <ul style="list-style-type: none"> <li>• Conduct Longitudinal and cross-sectioning surveys</li> <li>• Projecting a road of given gradient.</li> <li>• Blockleveling at the lowest level or valley curve</li> <li>• Connecting to new road alignment, surveying existing road 90m and exploring possibility of widening.</li> </ul> <p><b>3.Graded Exercise</b> : Preparation of <b>AUTOCAD</b> Drawings / <b>CIVIL 3D</b> software</p> <ul style="list-style-type: none"> <li>• Key Plan and Index plan</li> <li>• Plan showing alignment with Horizontal Curves of road and Section of Vertical curves</li> <li>• L.S &amp; C.S of Road at different chainages as per IRC standards (Report should justify the selected alignment with details of all geometric designs for horizontal curve and Vertical curves for the traffic volume and design speed to the proposed alignment )</li> <li>• Typical Cross Section of Road as per Pavement Design</li> <li>• Block leveling @ the lowest level or valley curve placing Culvert – Cross Drainage works               <ul style="list-style-type: none"> <li>○ Half plan at top &amp; half plan at foundation.</li> <li>○ Half sectional elevation. half front elevation.</li> </ul> </li> </ul>	21
1,2 ,3	7	3		
1,2 ,3	7	4		



			<ul style="list-style-type: none"> <li>○ Half Cross section @centre half Cross section @ abutment</li> </ul>				
			<b>3.Quantity surveying</b> <ul style="list-style-type: none"> <li>• Earthwork Calculation from the cross-section area at different chainages using <b>Spreadsheet.</b></li> <li>• Estimation of Cost of Construction and Maintenance of Proposed Project using <b>Spreadsheet.</b></li> </ul> <b>4.Project Planning</b> <ul style="list-style-type: none"> <li>• Prepare Project Schedule for New Highway Alignment using <b>M S Project / Primavera</b></li> </ul> <b>5.Experiments</b> <ul style="list-style-type: none"> <li>• Field sample of soil to be collected and laboratory and insitu experiments to be conducted to determine the Index and engineering properties of soil- Subgrade and results to be reported</li> <li>• Based on Pavement design for type of pavement proposed – Pavement materials to be laboratory tested and results to be reported</li> </ul> <b>6. REPORT</b> <ul style="list-style-type: none"> <li>• AUTOCAD Drawings</li> <li>• Geometric Design for horizontal curve and Vertical curves proposed</li> <li>• Pavement design for type of pavement proposed</li> <li>• Details of Cross Drainage work proposed</li> <li>• Soil Investigation Report</li> <li>• Pavement Material Testing Report</li> <li>• Quantity Surveying Report – Earthwork Calculation, Estimation of Cost of Construction and Maintenance of Proposed Project</li> <li>• Project Planning report</li> </ul>				
		5	<b>CIE 4- Written and practice test</b>			Assessment Review and corrective action	3
1,2,3	7	6	<i>Industry Class-</i> <i>1. Highway Lightings</i>	1	4	<i>Industry weekly assignment</i>	

				2.Sustainable Pavements 3. Economic way of Constructing pavements and its layers and its purpose Ex: Cement Treated Sub Base(CTSB)						
10	4	1,2	1	1.Peer review on industry class 2.Progress review of Project 2, 3 and Assignment 1		4	Audio Visual Presentation on Introduction to Railway Engineering ( Surface Transportation)  1. Role and Features of Indian Railways 2. Advantages of Railways- Political, Social and Economical 3. Various components and requirements of a good track 4. Factors to be considered while selecting a good alignment 5. Forces acting on the track 6. Concept of coning of wheels and tilting of rails, Gradient and its types	1		2
	4	1,2	2	Audio Visual Presentation on Functions, Types and requirements of Track Components <ul style="list-style-type: none"><li>• Track</li><li>• Rails</li><li>• Sleepers</li><li>• Ballast</li></ul>	2	2	Audio Visual Presentation on Importance and Features of <ul style="list-style-type: none"><li>• Subgrade and Embankment</li><li>• Gauges</li><li>• Track Alignment ,fittings and Fastening</li><li>• Rail Joints and Welding of Rails</li><li>• Railway Stations and Yards</li></ul>	1		2
	4	1,2	3	Audio Visual Presentation on Importance and Features of <ul style="list-style-type: none"><li>• Points and Crossing</li><li>• Turnouts</li><li>• Track Junctions</li></ul>	2	2	Audio Visual Presentation on Importance and Features of <ul style="list-style-type: none"><li>• Track Drainage</li><li>• Track Maintenance</li><li>• Safety in Railways</li></ul>	1		2

			<ul style="list-style-type: none"> <li>• Signaling and Control system</li> </ul>			<ul style="list-style-type: none"> <li>• Modernization of railway track and future trends- High and super high speed railway system</li> </ul> <p><b>Case exercise ( Tutorial)</b> Study on Types of Rail Transportation and prepare presentation</p> <ul style="list-style-type: none"> <li>• Sub urban Rails</li> <li>• Rapid Rail Transit</li> <li>• Light Rail Transit</li> <li>• Monorail</li> </ul>			
4	1,2	4	<b>Audio Visual Presentation on Harbour - Water Transportation</b> <ol style="list-style-type: none"> <li>1. Introduction to Harbour, Purpose of providing Harbour</li> <li>2. Terminology - Dock, Port, Sea works for transportation Breakwater, Jetties, Quays, Dredging, Light house, Buoys and Beacons.</li> <li>3. Types of Harbor- Natural Harbor, Artificial Harbor, Ice-Free Harbors</li> </ol>	1	3	<b>Audio Visual Presentation on Airport- Air Transportation</b> <ol style="list-style-type: none"> <li>1. Terminology- Aerodrome, Apron, Hanger, Runway, Taxiway, Terminal area, Wind rose</li> <li>2. Factors affecting selection of site for airport</li> <li>3. Advantages and Disadvantages of Airport</li> <li>4. Importance of Airport Lighting</li> </ol>	1		2
		5	Developmental Assessment			Assessment Review and corrective action			3
4	1,2	6	<i>Industry Class-</i>  <b>Audio Visual Presentation on Construction stages/ phases of following</b>	1	4	<i>Industry weekly assignment</i>			

				<b>1.Railways system and Underground Railways in tunnels</b> <b>2.Harbour system</b> <b>3. Airport system</b>						
11	4	1, 2	1	1.Peer review on industry class 2.Presentation on types of railway transportation 2.Progress review of <b>Project 3</b>		4	<b>Audio – Visual Presentation on Introduction to Transportation Structures</b>  1. Bridges – Rail Bridge, Road Bridge and Pedestrian bridge 2. Tunnels and Culverts 3. Grade Separators - Flyovers ( Overpass and Underpass ) and Interchange 4. Retaining Walls in highways			3
	4	1, 2	2	<b>Audio Visual Presentation on Introduction to Bridges</b>  1. Component parts of a bridge  2. Terminologies - Water way, afflux, economic span of a bridge, scouring, free board, approach  3. Selection of site for bridges  4. Bridge Sub structure and Super structure	1	3	<b>Audio Visual Presentation on</b>  1. Types of Bridges based on Material <ul style="list-style-type: none"> <li>Temporary bridges – Timber bridges</li> <li>Permanent bridges - Masonry, Steel or R.C.C / Pre stressed bridges</li> </ul> 2. Types of Bridges based on Structure <ul style="list-style-type: none"> <li>Arch bridges and Tied Arch bridges</li> <li>Beam Bridges</li> <li>Truss Bridges</li> <li>Cantilever Bridges</li> </ul>	1		2

							<ul style="list-style-type: none"> <li>• Cable stayed bridges</li> <li>• Suspension bridges</li> </ul>			
4	2, 6	3	Audio Visual Presentation on <b>Tunnels:</b> <ol style="list-style-type: none"> <li>1. Terminology</li> <li>2. Advantages of tunnels</li> <li>3. Size and shapes of tunnels- horse shoe, egg shape, segmental roof section</li> <li>4. Transferring alignment inside the tunnel, mucking, concept of shafts</li> <li>5. Objects of tunnel lining and Ventilation</li> <li>6. Drainage in tunnels</li> </ol>	2		2	<b>Assignment 2 :</b> To be conducted In class in the form of Discussion and presentation <ol style="list-style-type: none"> <li>1. Compare the Local Bus transport system with the Metro Rails and Sub urban Railway systems ( Completed)available in different cities of India</li> <li>2. Compare the following parameters with respect to Roadways, Railways and Airport system :               <ul style="list-style-type: none"> <li>• Population of the cities</li> <li>• Project Completion Cost</li> <li>• Annual returns ( Income)</li> <li>• Ridership per annum</li> </ul>               Report which transportation system is most economical in different cities of India             </li> <li>3. Compare between road pavement and runway pavement of airports</li> </ol> <b>Assignment 3 :</b> To be conducted in class in the form of Discussion and presentation Report the following <ol style="list-style-type: none"> <li>1. Cities/ Places in India where Harbours and Airports are situated</li> </ol>			3

							<ol style="list-style-type: none"> <li>2. Study salient features in the airports situated in different cities of India.</li> <li>3. Project Completion Cost of those Harbours and Airports situated in different cities of India</li> <li>4. Types of Airports and Harbours situated in India</li> </ol>			
4	6	4	<p>Case study : Students shall be selecting different topics of interest on latest technology in transportation engineering, Conduct a case prepare a report and present</p> <p>Example:</p> <ol style="list-style-type: none"> <li>1. <a href="https://bengaluru.citizenmatters.in/no-potholes-in-electronics-city-roads-80916">https://bengaluru.citizenmatters.in/no-potholes-in-electronics-city-roads-80916</a></li> <li>2. <a href="https://auto.hindustantimes.com/auto/news/indias-first-ever-steel-road-opens-for-traffic-showcases-sustainable-model-41648449391277.html">https://auto.hindustantimes.com/auto/news/indias-first-ever-steel-road-opens-for-traffic-showcases-sustainable-model-41648449391277.html</a></li> <li>3. <a href="https://www.icvvirtualibrary.com/doi/10.1680/jcien.19.00046">https://www.icvvirtualibrary.com/doi/10.1680/jcien.19.00046</a></li> <li>4. <a href="https://www.iosrjournals.org/iosr-jmce/papers/AETM'15_CE/2/18-CE-128.pdf">https://www.iosrjournals.org/iosr-jmce/papers/AETM'15_CE/2/18-CE-128.pdf</a></li> <li>5. <a href="https://pdfcoffee.com/whitetopping-pdf-free.html">https://pdfcoffee.com/whitetopping-pdf-free.html</a></li> </ol>		4	<p><b>CASE STUDY 1 :</b> Conduct a case study on the construction procedure of the following and prepare a report</p> <ol style="list-style-type: none"> <li>1. Grade separators <ul style="list-style-type: none"> <li>• Underpass</li> <li>• Flyover – Overpass</li> <li>• Interchange</li> </ul> </li> <li>2. Retaining wall in highway construction</li> </ol>			3	



			5	<b>CIE 5- Written and practice test</b>			Assessment Review and corrective action			3
	4	7	6	<i>Industry Class on</i> <b>Audio Visual Presentation on Construction stages/ phases of following</b> <b>1.Bridges and Tunnels system</b> <b>2.Grade Separators, Interchanges and Retaining wall in highways</b>	1	4	<i>Industry weekly assignment</i>			
<b>12</b>	5	2	1	1.Peer review on industry class 2.Review of Assignment 2 and 3 and Case study 1		<b>4</b>	Audio Visual Presentation on Introduction to Multi Modal Transportation system <ul style="list-style-type: none"> <li>Public Transport- Bus Rapid Transit System (BRT) and Light Rail Transit system (LRT)</li> <li>Services and Freight</li> <li>Intermediate Para Transit</li> <li>Multi Occupancy Cars ( Car Pool )</li> <li>Marine transit system ( Maritime)</li> <li>Air transportation</li> </ul>	1		2
	5	5	2	<b>Audio- Visual Presentation on Road Safety</b> <ol style="list-style-type: none"> <li>Pedestrian Safety and Security</li> <li>Risk factors for Pedestrian Traffic Injury</li> <li>Road Crashes/ Accidents</li> <li>Factors influencing crashes</li> </ol>	1	3	<b>Road Safety Auditing – IRC SP 88</b> <ol style="list-style-type: none"> <li>Different Types of auditing</li> <li>Introduction to road safety auditing</li> <li>Need of road safety auditing</li> <li>Objectives of road safety auditing</li> <li>Benefits of road safety auditing</li> <li>Code of good practice and checklists</li> </ol>	1		2

			5. Safety Precautions to be considered for Road safety						
3,4	5		Audio- Visual Presentation on Stages of Road safety auditing <ol style="list-style-type: none"> <li>Auditing of Roads before opening to traffic               <ul style="list-style-type: none"> <li>Feasibility stage</li> <li>Preliminary design stage</li> <li>Detailed design Stage</li> <li>Pre –opening stage</li> </ul> </li> <li>Auditing of Existing roads               <ul style="list-style-type: none"> <li>Accidental data collection</li> <li>Inspection at Road Construction at accident black spot</li> <li>Inspection of Designs</li> <li>Assessment and Reviews</li> </ul> </li> </ol>	2		2	Audio- Visual Presentation on <ol style="list-style-type: none"> <li>Step wise procedure followed in the Road safety auditing</li> <li>General and Formal requirements of Road safety auditing</li> <li>Importance of Monitoring and Evaluation of road safety by auditing</li> </ol>		3
5	5, 6		Audio- Visual Presentation on <ol style="list-style-type: none"> <li>Environmental Impact Assessment of Transportation projects               <ul style="list-style-type: none"> <li>Screening and Scoping</li> <li>Establishing Baseline</li> <li>Impact Assessment</li> <li>Mitigating Impacts</li> <li>Monitoring and Evaluation</li> </ul> </li> <li>Health Impact Assessment of Transportation projects               <ul style="list-style-type: none"> <li>Current exposure to emissions ( air and noise pollution)</li> </ul> </li> </ol>	2		2	<b>CASE STUDY 2 ::</b> Students shall be selecting different topics of interest on following topics , Conduct a case study, prepare a report and present <ul style="list-style-type: none"> <li>Road safety auditing</li> </ul> Example : <a href="https://www.researchgate.net/publication/325116717_Road_safety_audit_a_case_study_on_NH-65">https://www.researchgate.net/publication/325116717_Road_safety_audit_a_case_study_on_NH-65</a>		3

			<ul style="list-style-type: none"> <li>Traffic Injury and Fatalities</li> <li>Current level of Physical activities</li> </ul>			<ul style="list-style-type: none"> <li>Environmental and Health Impact assessments of transportation systems</li> </ul> <p>Example :</p> <p><a href="https://www.researchgate.net/publication/335365145_Impact_Assessment_of_Road_Construction_on_Rural_Accessibility_A_Case_Study_in_India">https://www.researchgate.net/publication/335365145_Impact_Assessment_of_Road_Construction_on_Rural_Accessibility_A_Case_Study_in_India</a></p> <ul style="list-style-type: none"> <li>Sustainability – Reclaimed Asphalt Pavement</li> <li>Usage of alternative materials in road construction</li> </ul> <p>Example:</p> <p>1. <a href="https://www.researchgate.net/publication/346892421_Case_Studies_of_Sustainable_Road_Transport_Practices_in_Different_Industry_Sectors_in_India">https://www.researchgate.net/publication/346892421_Case_Studies_of_Sustainable_Road_Transport_Practices_in_Different_Industry_Sectors_in_India</a></p> <p>2. <a href="https://www.fhwa.dot.gov/pavement/sustainability/case_studies/">https://www.fhwa.dot.gov/pavement/sustainability/case_studies/</a></p>			
		5	Developmental assessment			<p>1. Assessment Review and corrective action</p> <p>2. Review of <b>Case study 1 and 2</b></p>			3
5	7	6	<i>Industry Class –</i> <i>1. Intelligent Transportation System</i> <i>2. Sustainable Transportation system</i> <i>3. Application of Drone, GIS and Radar Survey in Transportation Engineering</i>	1	4	<i>Industry weekly assignment</i>			

13	6	<p><b>Internship</b></p> <p>a) Secondary research on various industries and their operations to identify at least 3 companies along with the areas of work interest and develop an internship plan that clearly highlights expectations from the industry during the internship.</p> <p>b) Design and develop a cover letter for an internship request to all 3 identified companies and the resume to be submitted to potential companies.</p> <p>c) Prepare for an internship interview to highlight your interests, areas of study, career aspirations and personnel competence - including the areas of learning you expect to learn during internship.</p>	<p><b>Project</b></p> <p>a) Identification of the problem statement (from at least 3 known problems) the students would like to work as part of the project - either as provided by faculty or as identified by the student. Document the impact the project will have from a technical, social and business perspective.</p> <p>b) Design and develop the project solution or methodology to be used to solve at least one of the problems identified.</p> <p>c) Prepare a project plan that will include a schedule, WBS, Budget and known risks along with strategies to mitigate them to ensure the project achieves the desired outcome.</p>
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Note: Saturday session from 9 AM -2 PM

1. Students shall be encouraged by conducting more number of field visits / site visits at the construction stage as and when course content demands to gain more exposure  
Ex: Airport, Harbour, Road, Railway, Tunnel, Bridge, Metro, Flyover, Underpass, Retaining wall
2. Industry classes for content mentioned shall be conducted from Industry experts in that area of interest
3. Students shall be encouraged to give presentation on Important IRC codal provisions and MORTH Specifications every week whose knowledge is important in Construction field

**CIE and SEE Assessment Methodologies**

CIE Assessment	Assessment Mode	Duration In hours	Max Marks
Week 3	CIE 1- Written and practice test	4	30
Week 5	CIE 2- Written and practice test	4	30
Week 7	CIE 3- Written and practice test	4	30
Week 9	CIE 4- Written and practice test	4	30
Week 11	CIE 5- Written and practice test	4	30
	On line Course work (Minimum 10 hours online course with certification from (SWAYAM/NPTEL/Infosys Springboard)		40
	Profile building for Internship / Submission of Synopsys for project work		20
Portfolio evaluation (Based on industrial assignments and weekly developmental assessment) *			30
<b>TOTAL CIE MARKS (A)</b>			<b>240</b>
<b>SEE 1 - Theory exam (QP from BTE) Conducted for 100 marks 3 hrs duration reduced to 60 marks</b>		<b>3</b>	<b>60</b>
<b>SEE 2 - Practical</b>		<b>3</b>	<b>100</b>
<b>TOTAL SEE MARKS (B)</b>			<b>160</b>
<b>TOTAL MARKS (A+B)</b>			<b>400</b>

\* The industrial assignment shall be based on peer-to-peer assessment for a total of 10 marks (on a scale of 1 to 10) and in the event of a group assignment the marks awarded will be the same for the entire group, the developmental assessment will be for a total of 20 marks and based on MCQ/case study/demonstration and such other assignment methods

## Assessment framework for CIE 1

Note : Theory to be conducted for 1 hour and practice for 3 hours, total duration of exam - 4 hours

Programme	Civil Engineering	Semester	V																																																						
Course	Transportation Engineering	Max Marks	30																																																						
Course Code	20CE531	Duration	4 hours																																																						
Name of the course coordinator																																																									
Note: Answer one full question from each section.																																																									
Qn.No	Question	CL	CO	PO	Marks																																																				
Section-1 (Theory) – 10 marks																																																									
1.a)	The speeds of overtaking and overtaken vehicles are 70 kmph and 40 kmph, respectively on a two-way traffic road. If the acceleration of the overtaking vehicle is 0.99 m/sec <sup>2</sup> , a) Calculate safe overtaking sight distance <b>(3)</b> b) Compute the sight distance that can be provided at zones where OSD is not providable <b>(1)</b> c) Show the positions of the sign posts on a neatly drawn sketch of overtaking zone <b>(2)</b> .	4	1	1,2,3	5																																																				
b)	The following table is the volume count data collected by an enumerator in an urban mid-block section. Find the Peak hour Volume <b>(3)</b> and Peak hour factor (PHF) <b>(1)</b> . Give your inference on the results <b>(1)</b> <table border="1"><thead><tr><th>TIME INTERVAL</th><th>LCV</th><th>CAR</th><th>2 wheelers</th></tr></thead><tbody><tr><td>2:30 – 2:40</td><td>10</td><td>16</td><td>24</td></tr><tr><td>2:40 – 2:50</td><td>12</td><td>9</td><td>33</td></tr><tr><td>2:50 – 2:60</td><td>13</td><td>8</td><td>27</td></tr><tr><td>3:00 – 3:10</td><td>13</td><td>15</td><td>32</td></tr><tr><td>3:10 – 3:20</td><td>14</td><td>10</td><td>28</td></tr><tr><td>3:20 – 3:30</td><td>10</td><td>9</td><td>41</td></tr><tr><td>3:30 – 3:40</td><td>11</td><td>8</td><td>38</td></tr><tr><td>3:40 – 3:50</td><td>6</td><td>15</td><td>21</td></tr><tr><td>3:50 – 3:60</td><td>7</td><td>9</td><td>26</td></tr><tr><td>4:00 – 4:10</td><td>9</td><td>11</td><td>35</td></tr><tr><td>4:10 – 4:20</td><td>11</td><td>12</td><td>39</td></tr><tr><td>4:20 – 4:30</td><td>8</td><td>10</td><td>42</td></tr></tbody></table>	TIME INTERVAL	LCV	CAR	2 wheelers	2:30 – 2:40	10	16	24	2:40 – 2:50	12	9	33	2:50 – 2:60	13	8	27	3:00 – 3:10	13	15	32	3:10 – 3:20	14	10	28	3:20 – 3:30	10	9	41	3:30 – 3:40	11	8	38	3:40 – 3:50	6	15	21	3:50 – 3:60	7	9	26	4:00 – 4:10	9	11	35	4:10 – 4:20	11	12	39	4:20 – 4:30	8	10	42	3	1	1,2,3	5
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2.a)	The NH-75 segment passing through Yeshwanthpur to Hebbala flyover has a horizontal curve at Kuvempu Circle bus stop near Lottegollahalli railway station (after BEL circle) with absolute minimum radii. Design the following geometric features of this curve assuming suitable data for a design speed of 80 kmph. a. Super elevation (1) b. Extra widening (1) c. Length of the transition curve (2) d. Stopping sight distance(1)	4	1	1,2,3	5																						
b)	<div>The following Spot speed data was collected from a mid-block section</div> <table><thead><tr><th>Speed Range ( KMPH)</th><th>Frequency</th></tr></thead><tbody><tr><td>0-10</td><td>5</td></tr><tr><td>10-20</td><td>10</td></tr><tr><td>20-30</td><td>15</td></tr><tr><td>30-40</td><td>20</td></tr><tr><td>40-50</td><td>25</td></tr><tr><td>50-60</td><td>30</td></tr><tr><td>60-70</td><td>25</td></tr><tr><td>70-80</td><td>20</td></tr><tr><td>80-90</td><td>15</td></tr><tr><td>90-100</td><td>15</td></tr></tbody></table> <div>a) Plot the frequency distribution and cumulative frequency distribution curves from this data (3) b) Compute the design speed (1 ) c) Compute Speed limits (1)</div>	Speed Range ( KMPH)	Frequency	0-10	5	10-20	10	20-30	15	30-40	20	40-50	25	50-60	30	60-70	25	70-80	20	80-90	15	90-100	15	3	1	1,2,3	5
Speed Range ( KMPH)	Frequency																										
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60-70	25																										
70-80	20																										
80-90	15																										
90-100	15																										
Section-2 (Practical) - 20 marks																											
3)	In a highway project, based on the field survey data, Civil Draftsman has prepared key plan and alignment is fixed. In this plan, it is observed that in one point there is a change of direction and it is to be provided with as Compound Curve based on design criteria at office. <ul style="list-style-type: none"><li>You as a Site engineer assume the field as that point where compound curve has to be set out using Total station along with your team</li><li>What are the instruments you need to carry along with you before going into field</li></ul>	3	1		10																						

	<ul style="list-style-type: none"> <li>Explain and execute how you set out compound curve in that field for the design data given</li> </ul>				
4)	<p>You have a team of site engineers working in road project of Shiradi Ghat</p> <ul style="list-style-type: none"> <li>You have received the geometric designs showing many number of reverse curves</li> <li>Assume the field as your project site, What are the instruments you need to carry along with you before going into field</li> <li>Explain and Execute one reverse curve as per the design data given</li> </ul>	3	1		10

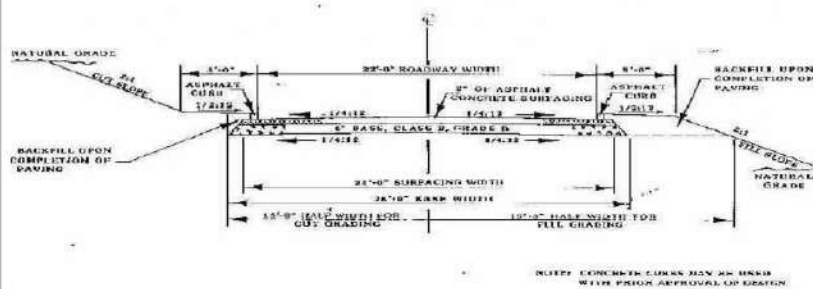
**Note : Theory questions shall be aligned to practical questions**

## Assessment framework for SEE 1 (Theory) – 100 Marks / 3 hours (Reduced to 60 marks)

Programme : Civil Engineering		Semester: V																			
Course : Transportation Engineering		Max Marks: 100																			
Course Code :20CE531		Duration : 3 Hrs																			
Instruction to the Candidate: Answer one full question from each section.																					
Q.No	Question	CL	CO	Marks																	
Section-1																					
1.a)	A Valley curve is formed by a descending gradient of 1 in 40 which meets an ascending gradient of 1 in 30. <ul style="list-style-type: none"><li>Design the total length of valley curve if the design speed is 100 kmph so as to fulfill both comfort condition and head light sight distance for night driving after calculating the SSD required. (8)</li><li>Determine the position of the lowest point of the valley curve to locate the culvert(2)</li></ul>	3	1	10																	
b)	An Engineering student in 6 <sup>th</sup> semester is doing Internship under Directorate of Urban Transport (DULT) in Bangalore. He has been asked to Conduct Origin and Destination study of an area in Malleswaram. Explain the stepwise procedure he should follow to conduct the following surveys <ul style="list-style-type: none"><li>Home Interview Survey</li><li>Road side Interview survey ( with neat sketch)</li></ul>	3		10																	
2.a)	A highway engineer wants his team to conduct engineering survey for a new highway project. Elaborate the stages of engineering surveys his team need to conduct for a new highway alignment	3		10																	
b)	A Probe car / Moving car was used to estimate Flow, Density and Speed. Use the following data to Estimate q, k, v and plot the q-v graph in the graph sheet <table><tr><th>Vehicles moving against the stream</th><th>Vehicles that had overtaken the test vehicle</th><th>Vehicle overtaken by the test vehicle</th></tr><tr><td>120</td><td>15</td><td>75</td></tr><tr><td>135</td><td>25</td><td>50</td></tr><tr><td>40</td><td>20</td><td>10</td></tr><tr><td>90</td><td>20</td><td>10</td></tr><tr><td colspan="3">Length of the road : 0.5 Km, Speed of the car : 20 Kmph</td></tr></table>	Vehicles moving against the stream	Vehicles that had overtaken the test vehicle	Vehicle overtaken by the test vehicle	120	15	75	135	25	50	40	20	10	90	20	10	Length of the road : 0.5 Km, Speed of the car : 20 Kmph			3	10
Vehicles moving against the stream	Vehicles that had overtaken the test vehicle	Vehicle overtaken by the test vehicle																			
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Length of the road : 0.5 Km, Speed of the car : 20 Kmph																					
Section-2																					

3.a)	<p>As a part of certain highway consultancy project, the subgrade soil sample was characterized for assessing its plasticity properties as well as the classification of soil.</p> <ul style="list-style-type: none"><li>• Liquid limit of the soil = 55%</li><li>• Plastic limit of the soil= 30%</li></ul> <p>Grain size distribution was done on the same soil sample and test results are given below</p> <table><tr><td>Particle size in mm</td><td>2.0</td><td>0.6</td><td>0.3</td><td>0.15</td><td>0.075</td><td>0.032</td><td>0.009</td><td>0.0015</td></tr><tr><td>Percentage Finer</td><td>100</td><td>85</td><td>71</td><td>61</td><td>50</td><td>38</td><td>28</td><td>10</td></tr></table> <ul style="list-style-type: none"><li>• Plot the grain size distribution plot and give the proportion of various fractions in the soil</li><li>• Classify the soil as per Indian Standard (IS) Classification System</li></ul>	Particle size in mm	2.0	0.6	0.3	0.15	0.075	0.032	0.009	0.0015	Percentage Finer	100	85	71	61	50	38	28	10	4	2	10						
Particle size in mm	2.0	0.6	0.3	0.15	0.075	0.032	0.009	0.0015																				
Percentage Finer	100	85	71	61	50	38	28	10																				
b)	<p>Enumerate the differences between the following</p> <ul style="list-style-type: none"><li>• Design parameters of Flexible and Rigid Pavements</li><li>• Pavement design aspects of Highways and Runways</li></ul>	3		10																								
4.a)	<p>Analyse the results of an asphalt concrete mix having weighed 1228 grams in air and 706 grams in water during the course of Marshal Stability test. Determine the following for the given data below</p> <ul style="list-style-type: none"><li>• Bulk Density and Theoretical Density</li><li>• Air Voids in total mix</li><li>• Voids in mineral aggregate</li><li>• Voids filled with bitumen</li></ul> <table><tr><th>Sl.NO.</th><th>MATERIAL</th><th>PERCENTAGE OF MATERIAL</th><th>SPECIFIC GRAVITY</th></tr><tr><td>1</td><td>Coarse aggregate</td><td>25</td><td>2.67</td></tr><tr><td>2</td><td>Fine aggregate</td><td>35</td><td>2.68</td></tr><tr><td>3</td><td>Stone dust</td><td>40</td><td>2.72</td></tr><tr><td>4</td><td>Filler</td><td>2</td><td>3.02</td></tr><tr><td>5</td><td>Bitumen</td><td>5</td><td>1.02</td></tr></table>	Sl.NO.	MATERIAL	PERCENTAGE OF MATERIAL	SPECIFIC GRAVITY	1	Coarse aggregate	25	2.67	2	Fine aggregate	35	2.68	3	Stone dust	40	2.72	4	Filler	2	3.02	5	Bitumen	5	1.02	4		10
Sl.NO.	MATERIAL	PERCENTAGE OF MATERIAL	SPECIFIC GRAVITY																									
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4	Filler	2	3.02																									
5	Bitumen	5	1.02																									
b)	<p>Outline in detail the material specification, Construction process and quality control tests of Wet Mix Macadam layer in road construction as per MORTH Specifications and IRC code of practice</p>	3		10																								

Section- 3																																			
5.a)	In a highway project a volumetrically unstable soil is encountered as a subgrade material. As a consequence of this problematic soil, the pavement is undergoing lot of distress quite frequently after laying it. <ul style="list-style-type: none"><li>What suggestions would you give to your client who approaches with this problem?</li><li>What are the probable Mechanism involved in the suggested Stabilization method that could overcome the problem</li></ul>										3	3																							
b)	Estimate the quantity of earthwork for the portion of a road between chainages 0 to 10 from the following data, lengths being measured with a standard 20m chain. <table border="1"><tr><td>Chains</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td>G.L.</td><td>131.1</td><td>131.2</td><td>130.9</td><td>130.8</td><td>130.7</td><td>130.6</td><td>130.4</td><td>129.1</td><td>129.5</td><td>129</td></tr></table> <p>The formation level at 0 chainages is 130.0 and the road is in a rising gradient of 1 in 200. The width of formation 9 m. and the side slopes 1.5: 1 in banking and 1:1 in cutting. The lateral slope of the ground may be assumed as level</p>										Chains		0	1	2	3	4	5	6	7	8	9	G.L.	131.1	131.2	130.9	130.8	130.7	130.6	130.4	129.1	129.5	129	4	10
Chains	0	1	2	3	4	5	6	7	8	9																									
G.L.	131.1	131.2	130.9	130.8	130.7	130.6	130.4	129.1	129.5	129																									
6.a)	1) As a Technical head of a forthcoming highway project, How would you emphasize the requirements of highway drainage system (5) 2)With a neat sketch explain the method of lowering of ground water table in a previous soil by providing subsurface drains (5)										3	10																							
b)	Estimate the quantities of the following items of works for the cross section of a 1km long road shown in fig										4		10																						



1. Earthwork excavation for the pavement shown in figure
2. 6" Base concrete for the road.
3. Top concrete surface.
4. 2" Asphalt layer above top layer.
5. Asphalt curbing on both sides 20m

## Section-4

7.a)	You are proposing a railway track to proposed alignment <ul style="list-style-type: none"> <li>What are the various components and requirements of a good track to be considered for proposing a railway track</li> </ul>	3	4	10
b)	You are working in bridge construction project, <ul style="list-style-type: none"> <li>What are the factors you consider for selection of site for bridge Construction?</li> <li>Draw a typical cross-section of bridge and show its components</li> </ul>	3		10
8.a)	As a site engineer while surveying and fixing alignment of railway track, you will encounter some place where tunnel needs to be constructed based on the conditions. <ul style="list-style-type: none"> <li>Justify your decision of constructing tunnel with the advantages of tunneling</li> <li>Justify why tunnel lining and ventilation should be given</li> </ul>	3		10
b)	You are working in Airport construction project <ul style="list-style-type: none"> <li>What are the factors you consider for selection of site for airport Construction?</li> <li>What is the importance of Airport lighting in the project?</li> </ul>	3		10



Section-5				
9.a)	Road safety auditing has been conducted by auditors to check road safety aspect. • Explain Step wise procedure followed in road safety auditing	3	5	10
b)	Explain the procedure of environmental Impact assessment process for a highway project	3		10
10.a)	What are the risk factors and safety precautions to be taken for road safety	3		10
b)	Explain the procedure of Health Impact assessment process for a highway project	3		10

**Scheme of Evaluation for SEE 2**

Sl. No	Description	Marks: 100
<b>Problem statement</b>	Condition: A consultancy company has been requested to design paving mix and conduct Marshal stability test for Dense Bituminous Macadam (DBM) layer in the construction field. You as an employee of the consultancy company is assigned with the following works	
1	Preparation of Mix design of the Bituminous paving mix from the data given from pavement material tests	10
2	Gradation and Proportioning of aggregates for DBM construction work by Rothfutch's Graphical method	10
3	Preparation of Test Specimen for different proportions of bitumen content	25
4	Determination of weight and dimensions or volume of test specimens	05
5	Conduction of Marshal Stability test to determine Marshal Stability values and Flow Values	20
6	Tabulation and calculations of the test results	10
7	Plotting of graphs, Interpretation of test data and Calculations to determine Optimum Bitumen Content (OBC)	20
<b>Total</b>		<b>100</b>

**References:**

Sl. No.	Description
1	" Highway Engineering " by Khanna S.K. and Justo C.E.G, , Nemchand and Bros, Roorkee
2	" Highway Material Testing Laboratory Manual" by Khanna SK and Justo CEG, Nemchand and Bros. Roorkee
3	" Highway Engineering " by Kadiyali L.R, , Khanna Publishers, New Delhi
4	" Traffic Engineering and Transport Planning " by Kadiyali L R
5	"Railway Engineering "by Satish Chandra and Agarwal M M, Oxford university press.
6	IRC Codal Provisions
7	Transportation Engineering and related courses in NPTEL , Swayam
8	Industry Consultation
9	Web searches

**1. List of equipments**

Sl.NO.	PARTICULARS	QUANTITY
1	Mechanical Sieve Shaker	2
2	Set of IS sieves for coarse aggregates	2 sets
3	Set of IS sieves for fine aggregates	2 sets
4	Casagrande's apparatus	2
5	Hot air Oven	1
6	Standard Proctor test apparatus	1
7	Modified Proctor test apparatus	1
8	Impact testing machine	2
9	Los Angeles abrasion testing Machine	1
10	Compression Testing Machine	1
11	Water Bath	1
12	Electric Heater for bitumen	1
13	Length gauge and Thickness gauge	2
14	Set of Pycnometers and Beaker- Different sizes	2 sets
15	Crushing test apparatus- Moulds	2 sets
16	Penetrometer and mould	1
17	Briquette Moulds and Ductility Machine	1 set
18	Ring and Ball Apparatus	2 sets
19	Cannon Fenske Opaque Viscometer /	2
20	Penskey Martens Closed cup apparatus	2
21	Total Station with Target	2 sets
22	Auto Level with Levelling Staff	2
23	Tapes	2
24	Ranging rods	6
25	Arrows	20