Semester- I

APPLIED STATISTICS FOR TRANSPORTATION ENGINEERING
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Course Code	**22CTM11**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: The goal of the course Applied statistics for traffic engineering is

1. To felicitate the student with a concrete foundation of fundamental statistics and probability.
2. To Useappropriatestatisticaltestingtoolstocheckthedegreeofaccuracyinthetrafficdataanalysis andassesstheerrorinvolvedinthedataanalysis
3. To develop the knowledge of statistical packages like MATLAB,MINITABforanalysisoftraffic data

Module-1

Introduction to statistical methods- Scope, aim and limitations, sample, attribute and types of data sources and collection of data. Accuracy of data. Representation and summarizing data. Frequency distribution, histogram, and frequency curves. Ogive curve, Measure ofcentral tendency–arithmetic mean, medianandmode, Dispersion-range,standarddeviation,varianceandco-efficientof variation, skewness, and kurtosis

Teaching-Learning Process	Chalk and talk method / Power point presentation

Module-2

Correlation and Regression: Curve fitting by the method of least square, Simple correlation analysis, Simple regression analysis, Multiple correlation and Regression , Rank correlation coefficient (both non repeated and repeated) , Application of Traffic engineering problems.

Teaching-Learning Process	Chalk and talk method / Power point presentation

Module-3

Introduction to probability & Probability distribution– Introduction,basiclawsofprobability,: Discrete probability distribution :binomialandPoissondistribution,continuous Probability distribution: normal distribution,Poisson distribution and Uniform distribution.

Teaching-Learning Process	Chalk and talk method / Power point presentation

Module-4

Sampling Techniques– Objective, basics of sampling, advantages of sampling, sampling techniques, sampling distributions, samplingdistributionofthesamplemean,centrallimit theorem, chi-square, and F-distributions.Samplingerror,samplesize anddesign, Analysis of Variance.

Teaching-Learning Process	Chalk and talk method / Power point presentation

Module-5

Statistical decisions and Testsofsignificance –
Pointestimation,propertiesofparameters,TestingofHypothesis –Type I and II errors., testsformeanandvariance, Testsfor proportions,

Students t – distribution

Useofsoft-warefor statisticalanalysis–MATLAB, MINITAB

Teaching-Learning Process	Chalk and talk method / Power point presentation

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** and **Skill Development Activity of 40 marks**
   to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books:-

1. Johnson R and G Bhattacharya, "Statistics–Principles and methods" JohnWiley&sons,Newyork,1985
2. L.RKadiyali,"TrafficEngineering"-KhannaPublishersNewDelhi
3. Medhi,"Introductiontostatistics"-NewAgePub,NewDelhi
4. Agarwal,B.L,"BasicStatistics"-3rdedition,NewAgePublicationNewDelhi
5. BenjaminJackRandCornellCAllin,"ProbabilityStatistics&DecisionsforCivil Engineers" – Mc-Graw Hill Co

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc22_ce31
- https://youtu.be/iVYHpmQ3tQQ
- VTU e- Shikshana Programme
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignment
- Seminars
- Field study

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Usestatisticaltoolstoexpressthetrafficdataforbetterinterpretation	L1 &L3
CO2	usecurve fitting techniques, Regression Analysis for predicting the performance trends.	L2 &L3
CO3	Applyprobabilityconcepttounderstandthevehicularflowbehaviourhelpingtheplannersto predict traffic flow.	L3
CO4	Useappropriatestatisticaltestingtoolstocheckthedegreeofaccuracyinthetrafficdataanalysis.	L3 &L4
CO5	Testthehypothesisandidentifytheerrorinvolvedinthedataanalysis and also usesoftwaretoolslikeMATLAB,MINITAB for analysisoftrafficdata.	L2, L3 & L4

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and possess lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs :-

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**	**2**	**2**			
CO2	**2**	**3**	**3**			**2**
CO3	**2**					
CO4		**3**			**2**	**2**
CO5	**2**	**3**		**3**		**2**

Semester- I

Traffic Engineering (IPCC)

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Course Code	22CTM12	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:02:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

This course will enable students to

1. Analyze the factors affecting performance of road traffic and the various traffic studies needed for the analysis of traffic flow.
2. Evaluate accident studies, level of service and capacity of roadways using traffic data.
3. Propose traffic forecast methods and traffic control techniques
4. Design intersections at-grade and grade separated types for smooth and safe movement of vehicles.
5. Evaluate the parking and pedestrian facilities and general safety measures required for highways and expressways.

Module-1

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. Problems on above. Sampling in traffic studies–sampling techniques, sampling theory, accuracy and sample size.

Teaching-Learning Process	Chalk and Talk /Presentation/ Field studies

Module-2

Accident characteristics-causes, studies, investigations and analysis of individual accidents, statistical analysis, measures to improve road safety.

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

Teaching-Learning Process	. Chalk and Talk /Presentation/Group discussion

Module-3

Traffic forecast- factors affecting traffic forecast, Common methods of traffic forecast and econometric models.

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

Teaching Learning Process	Chalk and Talk /Presentation/Group discussion

Module-4

Design of signalized intersections –as per IRC guidelines. Signal system, Problems.

Design of other types of intersections at grade such as intersections with markings, channelized intersections and traffic rotary. Traffic design of grade separated intersections and interchange facilities.

Teaching-Learning Process	Chalk and Talk /Presentation/Group discussion

Module-5

Design of Traffic facilities – design on street and off-street parking facilities, pedestrian facilities, bus bays, safety devices. Design features of expressways and different types of Urban Roads	
Teaching-Learning Process	Chalk and Talk /Presentation/Group discussion

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Classified volume count survey
2	Origin Destination Survey
3	Spot speed Survey
4	Speed and Delay survey
5	Parking studies
6	Determination of street light facilities
7	Determination of LOS and Capacity Estimation at Intersection
8	Pedestrian Survey
9	Accident studies
10	TRAFFIC ENGINEERING PACKAGES: Signal Design TRANSIT SYNCRO ACCIDENT ANALYSIS PACKAGE TIME SERIES PACKAGE

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experimentsshall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

9. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
10. The question paper will have ten questions. Each question is set for 20 marks.
11. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
12. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Books

1.KadiyaliL.R."TrafficEngineeringandTransportationPlanning"-KhannaPublication,NewDelhi
2. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., `Highway Engineering', NemChandandBros, Roorkee
3. Nicholas J.Garber, Lester A. Hoel, "Traffic and Highway Engineering", Third Edition Thompson Learning.
4. IRC: SP:41-1994,IRCSP:31-1992,IRC43-1994,IndianRoadsCongress
5. MoRTH"TypeDesignsforIntersectionsonNationalHighways"-IndianRoadsCongress
6. MORTH"ManualforRoadSafetyinRoadDesign"-IndianRoadsCongress
7. Relevant Indian Road Congress (IRC) Codes .
8.Indian Highway Capacity Manual (Indo-HCM) CSIR, New Delhi.

For Practical component of IPCC:

1.User Manuals of various packages

2. Relevant IRC publications
3. C.S.Papacostas and P.D.Prevedouros "Transportation engineering & Planning", PHI learning
4. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., `Highway Engineering', NemChandandBros, Roorkee

Web links and Video Lectures (e-Resources):

1. https://youtu.be/4ej1XkAvzhc
2. https://nptel.ac.in/courses/105101008
3. https://youtu.be/1TKhZ90lngs

Skill Development Activities Suggested

- **To carry out field surveys for volume count, spot speed, O-D, Speed and delay, accident, parking , street light facilities**
- **Site visit**
- **Design of traffic facilities**

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Analyze the factors affecting performance of road traffic and the various traffic studies needed for the analysis of traffic flow	L3
CO2	Evaluate accident studies, level of service and capacity of roadways using traffic data.	L3
CO3	Propose traffic forecast methods and traffic control techniques	L2
CO4	Design intersections at-grade and grade separated types for smooth and safe movement of vehicles.	L4
CO5	Evaluate the parking and pedestrian facilities and general safety measures required for highways and expressways.	L3

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and possess lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	3	1	1	1
CO2	3	1	1	2	3	2
CO3	2	1	1	2	2	1
CO4	2	2	2	1	2	2
CO5	3	2	2	2	2	2

Semester- I

Transportation Infrastructure Design

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Course Code	**22CTM13**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:02	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	

Course Learning objectives:

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

Module-1

Design Controls – Topography, Driver characteristics, Vehicle Characteristics, Traffic, Capacity and Level of Service, Design Speed. Objectives of Geometric Design, Cross Section Elements: Design specifications; Pavement Surface characteristics – Skid Resistance, Road Roughness; Camber, Objectives, design standards. Specifications for hill roads. Introduction to IRC, DMRB, AASHTO codes for geometric design

Teaching-Learning Process	PowerPoint presentations

Module-2

Horizontal Alignment of Roads: Sight Distances – Stopping Sight Distance, Overtaking Sight Distance and Intermediate Sight Distance; Objectives of horizontal curves; Super elevation; Extra- widening on Curves; Transition Curves – Objectives and Design. Transition Curve setting methods.

Teaching-Learning Process	Chalk and Talk /PowerPoint presentations

Module-3

Vertical Alignment of Roads: Gradients – Types of Gradients, Design Standards; Vertical Curves – Summit Curves, Valley Curves and Design criteria for Vertical Curves; Importance of Sight Distances for Horizontal and Vertical Curves; Combination of Vertical and Horizontal Curves – Grade Compensation.

Teaching-Learning Process	Chalk and Talk /PowerPoint presentations

Module-4

Geometric Design of Intersections: Types of Intersections; Design Principles for Intersections; Design of At-grade Intersections – Channelization, Objectives; Traffic Islands and Design standards; Rotary Intersection – Concept, Advantages and Disadvantages; Grade separated Interchanges – Types, warrants and Design standards.

Teaching-Learning Process	Chalk and Talk /PowerPoint presentations

Module-5

Design of Geometrics by the usage of softwares: Open roads and Civil 3D, Requirements of Pedestrians; Pedestrian facilities on Urban Roads; Cycle Tracks – Guidelines and Design standards; Bus bays –Types and Guidelines; Design of On-street and Off-street Parking facilities – Guidelines for lay out Design, Traffic Signs and Markings.

Teaching-Learning Process	Chalk and Talk /PowerPoint presentations

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**
3. **Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Khanna S.K. and Justo,C. E.G.`HighwayEngineering', NemChandandBros.,2000.
2. DSIR, `Roads in Urban Areas', HMSO, London.
3. Jack E Leish and Associates, `Planning and Design Guide: At-Grade Intersections'. Illinois.
4. Relevant IRC Codes & Publications.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/107/105107220/
- https://archive.nptel.ac.in/courses/105/101/105101087/
- https://archive.nptel.ac.in/courses/105/105/105105107/
- https://www.youtube.com/watch?v=2VehMMP70HE&list=PLLy_2iUCG87C7nApYQjgkDA0p67fMaXnE

Skill Development Activities Suggested

- Able to design the cross-sectional elements of different classes of highways using MX Roads software.
- Site visits
- Exposure to IRC, DMRB, AASHTO codes
- Design of Geometrics by the usage of softwares: Open roads and Civil 3D

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	To design the cross-sectional elements of different classes of highways.	3
CO2	To design the components of horizontal and vertical alignment of different classes of highways.	5
CO3	To appreciate the various types of intersections and suggest the required measures.	4
CO4	To design the required facilities for pedestrians, bicycles, buses and parking	3

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	3	3	3	3	3	3
CO3	2	2	2	2	2	2
CO4	2	2	2	2	2	2

Semester- I

Pavement materials

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Course Code	**22CTM14**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:0:02	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: This course will enable students to

1.Understand the aggregates with respect to their shape, size and gradationrequirement which are most important in the construction of different pavement layers.

2.Understand the different types of bituminous binders and apply the knowledge in Suggesting suitable binder for road construction.

3. Understand the use of various binder materials that can be used for interface treatment during construction and repair works carried out on roads.

4. Analyse the properties and design the bituminous and cement concrete mixes for road construction.

5. Analyse the effect of weather on the properties and to understand the various tests that are to be conducted to check the adhesion failure in bituminous materials and mixes.

Module-1

Basic road construction materials –types, source, functional, requirements and properties,tests and specifications for use in various components of road.

Basic soil properties, methods to determine strength of soil, Soil compaction for use in fill and subgrade of roads, compaction studies in laboratory and field, properties of compacted soils.

Teaching-Learning Process	Chalk and Talk /Presentation/ Field studies

Module-2

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

Teaching-Learning Process	Chalk and Talk /Presentation/ Field studies

Module-3

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

Bituminous mixes,types,requirements,properties,tests,MarshallMethodofmixdesign,Criteria and super pave mix design,Additives &Modifiers inBituminousmixes,problemsonmixdesign.

Teaching-Learning Process	Chalk and Talk /Presentation

Module-4

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

Teaching-Learning Process	Chalk and Talk /Presentation/ Field studies

Module-5

Soil stabilization–principle, methods and tests, proportioning of materials and mix design, application of Rothfutch‟s method. Marginal and waste materials in road construction, their properties and scope in road construction. Use of Fly-ash in road embankment and cement concrete mixes, use of chemical stabilizers in road construction.

Teaching-Learning Process	Chalk and Talk /Presentation

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**
3. **Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Khanna, Justo and Veeraraghavan, "HighwayEngineering"-Nem Chand and Bros.,Roorkee
2. Freddy L Roberts,Prithvi S Kandhal ,"Hot Mix Asphalt Materials, mixture design and construction"-(2ndEdition), National Asphalt Pavement Association Research and Education Foundation , Maryland,USA
3. "BituminousmaterialsinRoadConstruction" –HMSOPublication.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105/106/105106203/
- **https://archive.nptel.ac.in/courses/105/105/105105107/**
- https://www.eng.auburn.edu/research/centers/ncat/research/other-publications.html

Skill Development Activities Suggested

- **Field visit to hot mix plant, RMC plant, GSB plant, and WMM plant**
- **Assignments**
- **Excel analysis**

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Identify and select based on their characteristics the basic construction materials for road construction.	L1
CO2	Design aggregate gradation for construction of pavement layers keeping in mind the density and strength parameters.	L4
CO3	Characterize the binder material for bituminous roads and provide an optimum bituminous mix design.	L3
CO4	Provide mix design procedure and the base layer for a CC pavement.	L1
CO 5	Propose soil stabilisation techniques for highway construction using locally available materials	L4

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	-	2	
CO2	2	3	-	2	2	
CO3	2	3	-	2	2	2
CO4	2	3	-	2	2	2
CO5	3	2			2	2

Semester- I

Soil Mechanics for Highway Engineers [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Course Code	22CTM15	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives:

After studying this course, students will be able to:

1. Determine the compaction characteristics.
2. Design surface and sub-surface drainage system as per field conditions.
3. Explore the sub-soil at a site.
4. Design an embankment by method of slices.
5. Explore the application of Geo-synthetics.

Module-1

Introduction to Soil and their Engineering Properties: Functions of Subgrade soil, Influence of soil properties on design and performance of pavement, embankments and foundations. Laboratory and field tests for the soil classification, methods of soil classification useful for highway, Importance ofcohesion, plasticity and volume change of soils. Frost actionin soils-factors, mechanics, depth of frost penetration, measures to decrease the damaging effects.

Soil Compaction: Introduction, Laboratory Tests, Factors affecting, Structure and Engineering behaviour of compacted cohesive soil, Field compaction specifications,Field compaction control, Different types of Equipments used for compaction, their choice.

Teaching-Learning Process	Black-Board Teaching, Presentation, Field Visit

Module-2

Highway Drainage:

Introduction, Importance, Surface drainage, Subsurface drainage, Methods, Design of subsurface drainage system, Road construction in water logged areas,

Teaching-Learning Process	Black-Board Teaching, Presentation,

Module-3

Soil Investigations: Soil surveys in highway projects. Methods of soil exploration, Boring, geophysical methods, Disturbed and undisturbed sampling. Site Investigation Report

Teaching-Learning Process	Black-Board Teaching, Presentation, Field Visit

Module-4

Stability of slopes: Introduction, Types, Different methods of analysis of slopes for Øu= 0 & C-Ø soil, Location of most critical circle, Earth dam slopes stability, Taylor's stability number, Problems on above

Teaching-Learning Process	Black-Board Teaching, Presentation, Field Visit

Module-5

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

Teaching-Learning	Black-Board Teaching, Presentation, Field Visit

Process	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**one Skill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. Gopal Ranjan and Rao A S R Basic and Applied Soil Mechanics New Age International Publication (P) Ltd New Delhi
2. Murthy V N S Principles of Soil Mechanics and Foundation Engineering UBS Publishers New Delhi
3. Punmia B C Soil Mechanics and Foundation Engineering Laxmi Publication New Delhi
4. Braja M Das Geotechnical Engineering Thomson Business Information India (P) Ltd India
5. S K Khanna and C E Justo Highway Engineering Khanna Publishers

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/101/105101084/
- https://archive.nptel.ac.in/courses/105/105/105105168/
- https://archive.nptel.ac.in/courses/105/106/105106052/

Skill Development Activities Suggested

- Demonstration of Compaction control in Laboratory
- Field Visit to highway sub-grade construction area.
- Demonstration of Standard Penetration Test and Geophysical Methods.
- Discussion on Case studies
- Use of Geotechnical software's.
- Problem solving using Excel

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Determine the compaction characteristics.	L3
CO2	Design drainage system as per field conditions	L4
CO3	Explore the sub-soil at a site	L5
CO4	Design an embankment by method of slices	L4
CO5	Explore the application of Geo-synthetics	L5

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**			**3**	
CO2	**3**	**3**				
CO3	**3**		**3**		**3**	
CO4	**3**		**2**		**3**	
CO5	**3**		**3**		**3**	

ResearchMethodologyand IPR			
CourseCode	**22RMI16**	CIEMarks	50
TeachingHours/Week(L:P:SDA)	3:0:0	SEEMarks	50
TotalHoursofPedagogy	40	TotalMarks	100
Credits	03	ExamHours	03

CourseLearningobjectives:

- Tointroducevarioustechnologiesofconductingresearch.
- Tochooseanappropriateresearchdesignforthechosenproblem.
- Chooseappropriatetoolfortheconductionofresearch.
- Toexplaintheartofinterpretationand theartof writingresearchreports.
- Toexplainvariousformsoftheintellectualproperty,itsrelevanceandbusinessimpactinthechangingglobalbusinesse nvironment
- TodiscussleadingInternationalInstrumentsconcerningIntellectualPropertyRights.

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research,TypesofResearch,ResearchApproaches,SignificanceofResearch,ResearchMethodsversusMethodology,R esearch and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria ofGood Research, and Problems Encountered by Researchers in India.**Defining the Research Problem:** ResearchProblem,SelectingtheProblem,NecessityofDefiningtheProblem,TechniqueInvolvedinDefiningaProblem, AnIllustration

Teaching-Learning Process	Chalkandtalk/PPT/casestudy

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your researchproblem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings,How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoreticalframework,Developingaconceptual framework,Writingaboutthe literaturereviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, ImportantConceptsRelatingtoResearchDesign,DifferentResearchDesigns,BasicPrinciplesofExperimentalDesigns,Import antExperimental Designs.

Teaching-Learning Process	Chalkandtalk/PPT/casestudy/webcontent

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample SurveyversusCensusSurvey,TypesofSamplingDesigns.**MeasurementandScaling:**QualitativeandQuanti tative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources ofError in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, MultidimensionalScaling, Deciding the Scale.**Data Collection:** Experimental and Surveys, Collection of Primary Data,CollectionofSecondaryData,SelectionofAppropriateMethodforDataCollection,CaseStudyMethod.

Teaching-Learning Process	Chalkandtalk/PPT/casestudy/webcontent

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, TestStatisticsandCriticalRegion,CriticalValueandDecisionRule,ProcedureforHypothesisTesting,HypothesisTestingfo rMean,Proportion,Variance,forDifferenceofTwoMean,forDifferenceofTwoProportions,forDifferenceofTwoVariances ,P-Valueapproach,PowerofTest,LimitationsoftheTestsofHypothesis.**Chi-square**
Test: Testof Difference ofmorethanTwoProportions,Test ofIndependenceofAttributes,TestofGoodnessofFit,

CautionsinUsingChiSquareTests	
Teaching-Learning Process	Chalkandtalk/PPT/casestudy/webcontent

Module-5

InterpretationandReportWriting: MeaningofInterpretation,TechniqueofInterpretation,PrecautioninInterpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report,Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing ResearchReports.**IntellectualProperty:**TheConcept,IntellectualPropertySystem in India,DevelopmentofTRIPSComplied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The GeographicalIndications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varietiesand Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets,Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales forProtection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation(WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right ofPriority,CommonRules,Patents,Marks,IndustrialDesigns,TradeNames,IndicationsofSource,UnfairCompetition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection ofLiteraryandArtisticWorks,BasicPrinciples,DurationofProtection,TradeRelatedAspectsofIntellectualProperty Rights(TRIPS) Agreement, Covered under TRIPS Agreement,Features of the Agreement, Protection ofIntellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, IndustrialDesigns,Patents, Patentable Subject Matter, Rights Conferred,Exceptions, Term of protection, Conditions onPatentApplicants,ProcessPatents,OtherUsewithoutAuthorizationoftheRightHolder,Layout-Designsof IntegratedCircuits,ProtectionofUndisclosedInformation,EnforcementofIntellectualPropertyRights,UNSECO.

Teaching-Learning Process	Chalkandtalk/PPT

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of themaximum marks of SEE.A student shall be deemed to have satisfied the academic requirements and earned thecredits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sumtotaloftheCIE(ContinuousInternalEvaluation)andSEE(SemesterEndExamination)takentogether.

ContinuousInternalEvaluation:

1. ThreeUnitTestseachof **20Marks**
2. Twoassignmentseachof**20Marks**or**oneSkillDevelopmentActivityof40marks** toattaintheCOsandPOs

Thesumofthreetests,twoassignments/skillDevelopmentActivities,willbe**scaleddownto50marks**

CIEmethods/questionpaperisdesignedtoattainthedifferentlevelsofBloom'staxonomyaspertheoutcomedefinedfor thecourse.

SemesterEndExamination:

1. TheSEEquestionpaperwillbe setfor100marksandthemarksscoredwillbeproportionatelyreducedto50.
2. Thequestionpaperwillhavetenfullquestionscarryingequalmarks.
3. Each full question isfor 20marks. There willbe two full questions(with amaximum of foursub-questions)from eachmodule.
4. Eachfullquestionwillhaveasub-questioncoveringallthetopicsunderamodule.
5. Thestudentswillhavetoanswerfivefullquestions,selectingonefullquestionfromeachmodule

SuggestedLearningResources:

TextBooks:

1. *Research Methodology: Methods and Techniques*, C.R. Kothari, Gaurav Garg,New Age International,4th Edition,2018..DouglasEComer,"InternetworkingwithTCP/IP,Principles,ProtocolsandArchitecture,"PHI,6thEdition

2. *Research Methodology a step-by-step guide for beginners.* (For the topic Reviewing the literature under module2),RanjitKumar,SAGEPublications,3rdEdition, 2011.

ReferenceBooks:

1. *ResearchMethods:theconciseknowledgebase,* Trochim,AtomicDogPublishing,2005.

2. *ConductingResearchLiteratureReviews:FromtheInternettoPaper,*FinkA,SagePublications,2009.

WeblinksandVideoLectures(e-Resources):

- https://www.youtube.com/watch?v=A7oioOJ4g0Y&list=PLVf5enqoJ-yVQ2RXUl6mCfLPf3J_JUfoc

Courseoutcome(CourseSkillSet)

Attheend ofthecoursethestudentwillbeableto:

Sl. No.	Description	Bloom's Level
CO1	Conduct research independently	L2
CO2	Choose research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	L2
CO3	Statistically interpret the data and draw inferences	L2

MappingofCOSandPOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9
CO1	**X**	**X**							
CO2	**X**	**X**							
CO3	**X**	**X**							

Advanced Pavement Laboratory
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Course Code	22CTML17	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

- The objective of this course is to make students learn the procedure and test the basic properties of soil, aggregates, bitumen, cement and concrete and its mix design

Sl.NO	Experiments
1	**Tests on soil as per Subgrade specifications** Grain size analysis - Wet sieve analysis, Liquid limit, plastic limit, soil classification (dry and wet), maximum dry density and moisture content, Field density by sand replacement & Core cutter method, Free swelling Index (FSI) and CBR test.
2	**Tests on aggregates for various granular layers** Aggregate gradation, shape tests, specific gravity, water absorption, Los Angeles abrasionvalue, aggregate impact value, Aggregate crushing test and soundness test.
3	**Tests on Bitumen for various bituminous layers** Softening Point Test, Penetration Test, Ductility Test, Thin film oven Test and Viscosity test
4	**Tests on Bituminous Mixes:** Stripping value of aggregate, determination of Gmm of given bituminous mixtures, Marshall mix design. ITS and Bituminous extraction test
5	**Tests on cement& concrete as per the Pavement quality concrete (PQC)** Strength tests on concrete (compression, and Flexural strength.) and Concrete Mix design as per IRC codes
	Demonstration Experiments (For CIE) if any
9	Dynamic shear rheometer test
10	Cyclic Triaxial test
11	UCS test
12	Brookfield viscometer test

Course outcomes (Course Skill Set):
At the end of the course the student will be able to:

- To conduct various tests on soil, aggregates, bitumen, cement and concrete as per IS and ASTM codes
- To analyse the suitability of materials for road construction as per IS, IRC and MORTH specifications
- To design granular mix, bituminous mix and concrete mix as per IS, ASTM and IRC Codes

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40%of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hours
Suggested Learning Resources: • Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., `Highway Materials and Pavement Testing', NemChand and Bros, Roorkee • Gambhir, M. L., 'Concrete Manual', Dhanpat Rai and sons New Delhi • Relevant IS and IRC codes • ASTM Codes

Semester- II

Advanced Traffic Engineering			
Course Code	22CTM21	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:02	SEE Marks	50
Total Hours of Pedagogy	30 hours Theory + 10 hours SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

1. Analyze and evaluate the methods of forecasting traffic and understanding basics of traffic forecast models
2. Analyse the evaluation of road by LOS values and PCU with different methods and determination of Design Hourly Volume.
3. Analyzing capacity of Mixed traffic Flow.
4. Analyze the evaluation techniques of accident studies and reconstructing accident for providing solutions for the accident problems.
5. Understand the traffic flow theories and its applications

Module-1	
Traffic Forecast: General travel forecasting principles, stages of traffic forecast, different methods of traffic forecast for future projection using IRC 108- 2015 and problems on above	
Teaching-Learning Process	Chalk and Talk/ Presentation/ Group work

Module-2	
Design Hourly Volume and Demand Functions: Concept of Design vehicle units, Determination of design hourly volume, methods of determination of PCU under mixed traffic conditions, Price-volume relationships, demand functions. Critical hour concept.	
Teaching-Learning Process	Chalk and Talk/ Presentation

Module-3	
Highway Capacity: Factors affecting capacity, level of service; Capacity studies- Capacity of different highway facilities including un signalised and signalised intersections. Norman's method ,Problems in Mixed Traffic flow; Case studies	
Teaching-Learning Process	Chalk and Talk/ Presentation

Module-4	
AccidentAnalysis: Analysis of individual accidents and statistical data; Methods of representing accident rate; Problems on above. Factors in traffic accidents; influence of roadway and traffic conditions on traffic safety; accident coefficients; Driver strains due to roadway and traffic conditions.	
Teaching-Learning Process	Chalk and Talk/ Presentation

Module-5	
Traffic Flow Theory: Fundamental flow relationship equations and their applications, Traffic flow theories and applications; Shock waves; Queuing theory and applications. **Probabilistic Aspects Of Traffic Flow:** Vehicle arrivals, distribution models, gaps and headway distribution models; gap acceptance merging parameters, applications.	
Teaching-Learning Process	Chalk and Talk/ Presentation/Group Discussion

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

3. Three Unit Tests each of **20 Marks**
4. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

6. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
7. The question paper will have ten full questions carrying equal marks.
8. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
9. Each full question will have a sub-question covering all the topics under a module.
10. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. KadiyaliL.R.,`Traffic Engineering and Transport Planning', KhannaPublications.
2. Drew, D.R., `Traffic Flow Theory and Control', McGraw Hill Book Co.
3. IRC-108-2015 Guidelines for Traffic Forecast on Highways
4. WohlandMartin,TrafficSystemsAnalysisforEngineersand Planners', McGraw Hill Book Co.
5. Pignataro,Louis,`TrafficEngineering –Theoryand Practice', John Wiley.
6. IRC Third Highway Safety Workshop, Lecture Notes 1978 and other IRC publications.
7. Gerlan,D.L.andHember,M.J.,`TrafficFlowTheory'-AMonograph,Special report 165 TRRB.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105101008
- https://youtu.be/Xrylfs7bB7s
- https://trid.trb.org/view/29147
- https://hithaldia.in

Skill Development Activities Suggested

- Field studies on PCU, capacity and Accident studies
- Demonstration of Softwares on Traffic flow theories
- Group discussion

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Analyze and evaluate the methods of forecasting traffic and understanding basics of traffic forecast models	L3
CO2	Analyse the evaluation of road by LOS values and PCU with different methods and determination of Design Hourly Volume.	L4
CO3	Analyzing capacity of Mixed traffic Flow.	L5
CO4	Analyze the evaluation techniques of accident studies and reconstructing accident for providing solutions for the accident problems.	L4
CO5	Understand the traffic flow theories and its applications	L3

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	3	1
CO2	3	3	2	1	3	2
CO3	3	3	3	3	3	3
CO4	3	3	2	3	3	3
CO5	3	2	1	1	2	2

Semester- II

Pavement Design and Analysis

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Course Code	**22CTM22**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	4	Exam Hours	3

Course Learning objectives:

This course will enable students to

1. Understand the factors affecting pavement design and performance
2. Evaluate the strength of soil subgrade soil and factors that affect the behaviour of soil.
3. Compute the stresses and deflections in flexible pavement layers under the action of wheel loads.
4. Design the thickness of flexible pavements by different methods under different exposure conditions and materials.
5. Design the thickness of concrete pavements and joints associated with CC pavements in addition to the computation of stresses in CC pavements.

Module-1

Pavement Types and Materials:

Types and component parts of pavements; highway and airfield pavements; basic characteristics of materials used in pavements.

Factors Affecting Pavement Design:

Variables considered in pavement design; Soil strength, classification of axle types, standard and legal axle loads, tyre pressure, contact pressure, ESWL, EWLF, and EAL concepts; traffic analysis: ADT, AADT, truck factor, growth factor, lane distribution factor, directional distribution factor, and vehicle damage factor.

Teaching-Learning Process	Chalk and Talk/ Presentation/Group Discussion

Module-2

Stresses in Flexible Pavements:

Layered system concepts; stress solution for one, two, and three-layered systems; fundamental design concepts; stress analysis in flexible pavements using KENLAYER.

Teaching-Learning Process	Chalk and Talk/ Presentation/ Assignment

Module-3

Stresses in Rigid Pavements:

Westergaard's theory and assumptions; joints in rigid pavements; stresses due to curling, stresses, and deflections due to loading, frictional stresses; stresses in dowel bars and tie bars, dowel group action; stress analysis in rigid pavements using KENSLABS.

Teaching-Learning Process	Chalk and Talk/ Presentation/ Assignment

Module-4

Design of Flexible Pavements:

IRC method of flexible pavement design; Asphalt Institute's design methods with HMA and other base combinations; AASHTO method of flexible pavement design; design of flexible pavement shoulders; introduction to mechanistic-empirical pavement design guide.

Teaching-Learning Process	Chalk and Talk/ Presentation/ Case studies/ Design in excel

Module-5

Design of Rigid Pavements:

IRC method of plain jointed, jointed reinforced, continuously reinforced rigid pavement design; design of conventional and thin whitetopping; AASHTO method of rigid pavement design; design of rigid pavement shoulders.

Teaching-Learning Process	Chalk and Talk/ Presentation/ Case studies/ Design in excel

PRACTICAL COMPONENT OF IPCC

Sl. NO	*Experiments*
1	***Traffic studies for Pavement design***
2	*Axle load analysis*
3	*Traffic growth rate analysis*
4	stress analysis in flexible pavements using KENLAYER.
5	*Flexible pavement design by IIT Pave software*
6	Stress analysis in rigid pavements using KENSLABS
7	*Rigid pavement design according to IRC 58 2015*
8	*Design of dowel bar*
9	*Design of Tie bar*
10	Design of thin white topping

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. *Two Tests each of **20 Marks***
2. *Two assignments each of **10 Marks/One Skill Development Activity of 20 marks***
3. *Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.*

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at

the end of the semester.

- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experimentsshall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Text Books:

1. Pavement Analysis and Design, Huang, Y.H., Dorling Kindersley (India) Pvt. Ltd., New Delhi, India, 2008, Second Edition.
2. Principles of Pavement Design, Yoder, E.J., and Witczak, M.W., Wiley India Pvt. Ltd., New Delhi, India, 2012, Second Edition.

Reference Books:

1. Guidelines for Conventional and Thin Whitetopping, IRC: SP76, Indian Roads Congress, New Delhi, India, 2015, First Revision.
2. Guidelines for Design and Construction of Continuously Reinforced Concrete Pavement, IRC: 118, Indian Roads Congress, New Delhi, India, 2015.
3. Guidelines for the Design of Flexible Pavements, IRC: 37, Indian Roads Congress, New Delhi, India, 2018, Fourth Revision.
4. Guidelines for the Design of Plain Jointed Rigid Pavements for Highways, IRC: 58, Indian Roads

Congress, New Delhi, India, 2015, Fourth Revision.
5. Thickness Design – Asphalt Pavements for Highways and Streets, Manual Series No. 1, Asphalt Institute, Kentucky, USA, 1999, Ninth Edition.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105104098
- http://onlinepubs.trb.org/onlinepubs/archive/mepdg/guide.htm
- http://www.trb.org/Pavements/TRBPublications.aspx
- https://link.springer.com/article/10.1007/BF03325749

Skill Development Activities Suggested

- Seminars /Quiz
- Assignment
- Simple problems solving by KENPAVE and IIT PAVE

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Get the knowledge of factors affecting pavement design and performance	L1
CO2	Compute the stresses and deflections in flexible pavement layers under the action of wheel loads.	L3
CO3	Design the thickness of flexible pavements by different methods under different exposure conditions and materials.	L4
CO4	Design the thickness of concrete pavements and joints associated with CC pavements in addition to the computation of stresses in CC pavements.	L4

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1				2	
CO2		2		2	1	1
CO3		3		3	3	3
CO4		3		3	3	3

Semester- II

PAVEMENT CONSTRUCTION AND EQUIPMENTS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Course Code	22CTM231	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

This course will enable students to

1. Understand the various equipment used for road construction
2. Select suitable equipment for preparation of subgrade in cutting or filling and also the preparation steps for base and sub base layers.
3. Recognize and use current pavement construction procedures.
4. Understanding common construction features important to the performance of both asphalt and concrete pavements.

Module-1

Construction of Subgrade:

Earthwork grading; compaction and construction of embankments; types of subgrade material, factors affecting strength gain; compaction requirement for subgrade; subgrade stabilization: preparation, compaction equipment, curing and opening to construction operation; construction involving geosynthetic application in embankment slope stability and reinforcement; quality control checks for embankment and subgrade construction.

Teaching-Learning Process	Chalk and Talk/ Presentation/ Field visit

Module-2

Construction of Unbound and Bound Granular Layers:

Gradation and material quality requirement for granular subbase and base layers, blending and proportioning, compaction requirements; field quality control; stabilized subbase and base layers: mix design, placing, laying and compaction requirements; crack relief and SAMI layer; geosynthetic application reinforced granular layers; construction of subsurface drainage for highways and airfield pavements.

Teaching-Learning Process	. Chalk and Talk/ Presentation/ Field visit

Module-3

Asphalt Plant Operations, Transport, and Delivery:

Asphalt plant functions; batch, drum, and continuous mix plants; emission controls; mix storage; asphalt mix transport: planning, haul trucks, addressing segregation, material transfer vehicle, visual inspection of the mix, and trouble shooting.

Teaching-Learning Process	Chalk and Talk/ Presentation/ Field visit

Module-4

Asphalt Paving Operation:

Preparing for paving: new construction/overlay, prime coat, tack coats: recommended applications, distribution, verifying the application rates; asphalt pavers and compaction; screed operations and control; joints; compaction mechanics; cold weather paving; roller types; sequence of rolling: breakdown, intermediate and finishing; tender mixes and compaction troubleshooting; quality assurance: sampling methods for asphalt mixtures; laboratory design verses field production; quality control tests; volumetric adjustments, density specifications.

Teaching-Learning Process	Chalk and Talk/ Presentation/ Field visit

Module-5	
Construction of Concrete Pavements: Concrete production; preparation of subgrade and base; reinforcement presetting for JPCP and CRCP; establishing string line; PCC slab constructions: slip form paving, fixed form paving; curing process; quantification of curing effectiveness; quality control tests; rehabilitation of concrete pavements.	
Teaching-Learning Process	Chalk and Talk/ Presentation/ Field visit

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

5. Three Unit Tests each of **20 Marks**
6. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
   to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Bituminous Road Construction in India, Kandhal, P.S., PHI Learning Pvt. Ltd, 2016, First Edition.
2. Specifications for Road and Bridge Works, Ministry of Road Transport and Highways, Indian Roads Congress, New Delhi, India, 2013, Fifth Edition.

REFERENCES:

1. Concrete Pavement Design, Construction and Performance, Norbert, J.D., CRC Press, 2014, Second Edition.
2. Construction of Quality Asphalt Pavements, MS-22, Asphalt Institute, 2020, Third Edition.

Web links and Video Lectures (e-Resources):

- https://www.virginiadot.org/vtrc/main/online_reports/pdf/15-r6.pdf
- https://www.youtube.com/watch?v=wku7YFDqK9w

Skill Development Activities Suggested

- Filed visit for students on HMA and RCC plant
- Filed visit for students on GSB and WMM plants
- Assignments

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Develop construction procedures for subgrade, unbound, and bound granular layers.	L3
CO2	Formulate strategies to produce optimal bituminous mixes.	L5
CO3	Propose appropriate construction procedures for bituminous and concrete layers.	L3
CO4	Choose appropriate pavement quality control test, and quantify construction variability	L5

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2.	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3.	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4.	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5.	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6.	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**			**1**	**2**	**1**
CO2	**2**	**1**			**1**	**1**
CO3	**2**				**2**	**2**
CO4	**2**		**1**		**1**	**1**

Semester- II

TRANSPORTATION STRUCTURES [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Course Code	**22CTM232**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:
This course will enable students to
1. Classify the various transportation structures,
2. Explain the principles of design methods and list the steps involved in the design of various transportation structures.
3. Identify the input parameters required for design of transportation structures
4. Design and evaluate a transportation structures based on the data given.

Module-1	
Introduction to pavement evaluation: Principles of Planning of Elevated Rail Transit System, grade separation structures, pedestrian crossing and sub- ways.	
Teaching-Learning Process	Chalk and Talk/ Presentation
Module-2	
Loads on Bridges: Dead loads, live loads, dynamic effects of vehicles, longitudinal forces, centrifugal forces, wind loads, earth quake forces, stream flow pressure, load combinations, design examples.	
Teaching-Learning Process	. Chalk and Talk/ Presentation/ Field visit
Module-3	
Design of Bridge Slabs: Longitudinally reinforced deck slabs, transversely reinforced bridge slabs.	
Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment
Module-4	
Design of Reinforced Concrete Bridges: Design procedures for T- beam, box girderNbridges design examples.	
Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment
Module-5	
Design of Pre-stressed Concrete Bridges: Complete design with case study.Design code, design examples.	
Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **oneSkill Development Activity of 40 marks**to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Raina,R.K, 'Principles of Design of RCC Bridges, Tata McGraw Hill,1999.
2. Krishnaraju 'Bridge Engineering', UPD Publishers, New Delhi,2000.

Reference Books:

1. Conrad P. Heins and Richard A. Lawrie, `Design of Modern Concrete Highway Bridges, John Wiley and Sons, 1999.
2. BaiderBakhtand Leslie, G. Jaeger,` Bridge Analysis Simplified, Mc Graw Hill Book Co,1998.
3. Johnson Victor, `Bridge Engineering', Oxford IBH, New Delhi, 2000.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/105/105105216/
- https://archive.nptel.ac.in/courses/105/105/105105165/

Skill Development Activities Suggested

- Field visit on construction of bridges
- Design of bridges by softwares
- Assignments

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Understand and classify the various transportation structures,	L1
CO2	Use the principles of design methods and list the steps involved in the design of various transportation structures.	L3
CO3	Identify the input parameters required for design of transportation structures	L5
CO4	Evaluate and design transportation structures based on the data given.	L5

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2.	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3.	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4.	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5.	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6.	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**					
CO2	**2**				**2**	**2**
CO3	**2**				**2**	**2**
CO4	**2**	**2**	**2**		**2**	**2**

URBAN PUBLIC TRANSPORT
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Course Code	**22CTM233**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:
This course will enable students to
1. Understand the various options for urban public transportation and recommend suitable mode for the given situation.
2. Conduct economic analysis between different transport modes and suggest most economical and efficient mode under the given set of conditions.
3. Understand the management of public transport system and developing strategies for efficient functioning of the system.
4. Carry out the evaluation of capacities of the system parameters such as routes, junctions, stations etc, to know the performance of the system.
5. Forecast the future transportation needs and variations in system components so as to plan for the transportation system requirements.

Module-1

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

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

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

Teaching-Learning Process	. Chalk and Talk/ Presentation/Assignment

Module-3

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

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-4

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

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

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

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. George E. Gray and Lester A. Hoel,'Public Transportation',Prentice Hall, New Jersey.
2. Vukan R. Vuchic,'Urban Public Transportation Systems and Technology, Prentice HallInc. NewJe
rsey.

Reference Books:

1. HorstR. Weigelt, Rainer E. Gotz, HelmutH. Weiss,' City Traffic-A Systems Digest' ,Van Nostrand Reinhold Company , New York
2. John W. Dickey, 'Metropolitan Transportation Planning', Tata Mc Graw-Hill Publishing Co. New Delhi

Web links and Video Lectures (e-Resources):

- .https://archive.nptel.ac.in/courses/105/105/105105204/
- https://archive.nptel.ac.in/courses/105/105/105105208/
- https://archive.nptel.ac.in/courses/124/105/124105016/

Skill Development Activities Suggested

- Field visit on public transport systems
- Town planning activities
- Assignments

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand the various options for urban public transportation and recommend suitable mode for the given situation.	L2
CO2	Conduct economic analysis between different transport modes and suggest most economical and efficient mode under the given set of conditions.	L3
CO3	Understand the management of public transport system and developing strategies for efficient functioning of the system.	L2
CO4	Carry out the evaluation of capacities of the system parameters such as routes, junctions, stations etc, to know the performance of the system.	L4
CO5	Forecast the future transportation needs and variations in system components so as to plan for the transportation system requirements.	L5

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2.	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3.	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4.	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5.	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6.	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**				**1**	
CO2	**2**		**2**	**1**	**2**	
CO3	**2**			**2**	**2**	**2**
CO4	**2**			**2**	**2**	**2**
CO5	**2**		**2**	**2**	**2**	**2**

Semester- 2

ADVANCED TRAVEL DEMAND MODELLING.
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Course Code	**22CTM234**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:
This course will enable students to
1. Develop discrete choice models.
2. Develop travel demand models using Stated Preference data.
3. Estimate Travel Demand using activity based analysis.
4. Assess Qualitative Variables.
5. Test model aggregation and transferability.
6. Develop Travel Demand Models for small cities using Quick response

Module-1

Discrete Choice Analysis: Utility Concept; Mode choice; Logit Models; Do git Model; Nested Logit Model; Pro bit Model; Route Choice Modelling; Combined Travel Demand Modelling; Model Parameter Estimation – Maximum Likelihood and Maximum Entropy Estimates.
Stated Preference Methods:
Stated preference vs. Revealed Preferences; Design Issues; Survey Methods, Conjoint Analysis; Functional Measurement; Trade off Analysis, Transfer Price Method

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Activity Based Travel Demand Models: Activity patterns; Activity scheduling; Activity Time Allocation studies; Activity Episode Analysis; Travel Duration Analysis

Teaching-Learning Process	. Chalk and Talk/ Presentation/Assignment

Module-3

Qualitative Variables: Role of Soft variables in Travel Demand Forecasting; Attitudes; Psychometric scaling Techniques – One-dimensional Scaling –Multidimensional Scaling; Basic Rating Scales: Comparative Rating Scales, Non –Comparative Rating scale, Itemised rating scale, graphic rating scale; Specific Attitude scales; Successive Categories; Principal Components Factor Analysis; Attitudinal Models

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-4

Model Aggregation and Model Transferability: Aggregation bias and forecasting; Aggregation Methods; Temporal Stability and geographical stability of Models; Transfer Model Updating Procedures –Transferring with Aggregate and Disaggregate sample data; Transferability Measures.
Simplified Travel Demand Models: Sketch planning Methods; Incremental Demand Models; Model estimation from traffic Counts; IVF Models, Marginal and Corridor Models; Gaming Simulation, Quick Response Techniques.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

Introduction to Advanced Modelling Techniques: GO Models; Entropy Models; Equilibrium Assignment Techniques, MultipathAssignment – Dial‟s Algorithm, Knowledge Based Expert System; Neuro –Fuzzy Application; ANN Techniques; Genetic Algorithms; Object Oriented Programming; Decision Support

Systems; Goal Programming.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs

3.The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Alan Geoffrey Wilson. Optimisation in Location and Transport Analysis, John Wiley &Sons, 1981 (Digitized: 31 March 2011).
2. Harry Timmermans, *Progress in Activity Based Analysis*, Elsevier Science, 2005

Reference Books:

1. Joe Castiglione, Mark Bradley and John Gliebe, Activity-Based Travel DemandModels: A Primer, TRB, Washington, D.C., 2015
2. Juan de Dios Ortuzar and Luis G. Willumsen, *Modelling Transport, 4th Edition*, JohnWiley and Sons, 2011.
3. Laurie A. Garrow, Discrete Choice Modelling and Air Travel Demand: Theory and Applications, Routledge, 2010
4. Moshe Ben-Akiva, and Steven R. Lerman, *Discrete Choice Analysis: Theory and Application to Travel Demand*, The MIT Press, Paperback 2018.
5. Norbert Oppenheim, *Urban Travel Demand Modelling: From Individual Choices togeneral Equilibrium*, John Wiley and Sons, Inc., 1995 (Digitized 29 June 2011).
6. Time use Analysis, Special Issue, Transportation, 26, Kluwer Academic Publishers,1999.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/104/105104098/
- https://archive.nptel.ac.in/courses/105/106/105106058/

Skill Development Activities Suggested

- Industry visit
- Assignment

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Develop discrete choice models.	L3
CO2	Develop travel demand models using Stated Preference data.	L4
CO3	Estimate Travel Demand using activity based analysis.	L3
CO4	Assess Qualitative Variables.	L4
CO5	Develop Travel Demand Models for small cities using Quick response	L3

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2.	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3.	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4.	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5.	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6.	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**			**2**	**2**	**2**
CO2	**2**			**2**	**2**	**2**
CO3	**2**			**2**	**2**	**2**
CO4	**1**			**1**	**1**	**1**
CO5	**2**			**2**	**2**	**2**

Semester- II

THEORIES OF TRAFFIC FLOW [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Course Code	**22CTM235**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:
This course will enable students to
1. Learn the relationships and the types of flow theories.
2. Learn the concept of Macroscopic and Microscopic traffic flow models.
3. Learn the application of probabilistic aspects of vehicle arrivals, ueuing theory.
4. Learn the principles of application of GIS in traffic flow theory.

Module-1

Traffic Stream Parameters - Fundamental diagram of volume-speed-density surface. Discrete and continuous probability distributions. Merging manoeuvres - critical gaps and their distribution

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Macroscopic Models - Heat flow and fluid flow analogies - Shock waves and bottleneck control approach.

Teaching-Learning Process	. Chalk and Talk/ Presentation/Assignment

Module-3

Microscopic Models - Application of queuing theory - regular, random and Erlang arrival and service time distributions - Queue discipline – Waiting time in single channel queues and extension to multiple channels.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-4

Linear And Non-Linear Car Following Models - Determination of car following variables -Acceleration noise.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

Geographical Information System – Global Positioning System – Intelligent
Transportation Systems - Area
Traffic Control – Automatic Toll Col lection – Smart Cards – Collision
Detection System.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. Drew, D.R., Traffic Flow Theory and Control, McGrawHill.,1978TRB,Traffic Flow Theory-A Monograph, SR165,1975.
2. Burrough P .A .and Rachel A. McDonell, Principles of Geographical Information Systems, Oxford Publication,2004

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/105/105105215/
- https://archive.nptel.ac.in/courses/105/101/105101008/
- https://archive.nptel.ac.in/courses/105/104/105104098/

Skill Development Activities Suggested

- Excel analysis
- VISSIM software tutorials

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Able to apply the flow theories to field situations such as tollbooths, diversion Measures etc.	L3
CO2	Able to understand various car following theories	L2
CO3	Able to apply the concepts of vehicle arrivals to field situations such as exit ramps, entry amps etc. by queuing theory	L3
CO4	Able to appreciate the application of GIS techniques in traffic engineering	L2

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2.	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3.	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4.	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5.	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6.	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**			**2**	**2**	**1**
CO2	**2**			**1**		
CO3	**2**	**2**		**2**	**3**	**2**
CO4	**2**			**2**	**2**	**2**

Semester- II

PAVEMENT MANAGEMENT SYSTEM
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Course Code	**22CTM241**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:
This course will enable students to
1. Discuss the need of PMS in planning and maintaining the flexible pavements.
2. Discuss the performance of pavements, causes of failure, rating methods.
3. Formulate the development and application of models for pavement management.
4. Discuss the need of application of methods of prioritization and application of innovative methods
5. Discuss the application of Road Asset Management

Module-1

Introduction: Definition -Components of Pavement Management Systems, Essential features. Pavement Management Levels and functions: Ideal PMS- Network and Project levels of PMS- Influence Levels- PMS Functions- Function of Pavement evaluation.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Pavement Performance: Serviceability Concept- Development of Serviceability Index-PSI-RCI- Roughness-Roughness Components- Evaluation-Equipment- Universal Roughness standard- Techniques-IRI Application of Roughness Data in Network level and Project Level. Problems on Above

Teaching-Learning Process	. Chalk and Talk/ Presentation/Assignment

Module-3

Evaluation of Pavement Structural capacity: - Basics- NDT and Analysis -Condition Surveys Distress-Destructive Structural Analysis- Application in Network and Project Levels- Methods and Equipment-Combined Measures of Pavement Quality-Concept-Methods of developing a combined index-limitations. Problems on Above

Teaching-Learning Process	Chalk and Talk/ Presentation/Field studies

Module-4

Evaluation of Pavement Distress and Functional Aspects – Principles-Condition survey- Survey Methodology-Types of Distress-Examples-Equipment-Indexes-Applications of Distress data- Pavement Safety-Components –Evaluation-Basic Concepts of Skid resistance-Methods of measuring skid resistance

Teaching-Learning Process	Chalk and Talk/ Presentation/Field studies

Module-5

Pavement Maintenance -Surface distresses, types, causes and redial measures, types of maintenance, classification of maintenance activities, pavement maintenance norms maintenance, development of decision tree, decision matrix, selection of treatment strategies, local, global maintenance and rehabilitation strategies, HDM-4 applications, and life cycle cost analysis.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Ralph Haas and Ronald W. Hudson, 'Pavement Management System', McGraw Hill Book Co.1978.
2. Ralph Haas, Ronald Hudson Zanieswki. 'Modern Pavement Management, Kreiger Publications, New York, 1992.

Reference Books:

1. PIARC Guidelines
2. Proceedings of North American Conference on Managing Pavement, USA, 2004.
3. Proceedings of International Conference on Structural Design of Asphalt Pavements NCHRP, TRR and TRB Special Reports, USA, 2006.

Web links and Video Lectures (e-Resources):

- https://www.piarc.org/en/
- https://austroads.com.au/publications/pavement/agpt04k/operating-environment/the-managerial-environment/pavement-management-systems-pms
- https://www.tam-portal.com/document/aashto-transportation-asset-management-guide-2/

Skill Development Activities Suggested

- Field studies on MERLIN, BBD and FWD
- Exposure to softwares like HDM 4 and Paver

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand the role of pavement management system in pavements	L2
CO2	Assess functional and structuralstrength of pavements	L4
CO3	Explain the use of models for pavement management.	L2
CO4	Select appropriate pavement rehabilitation options.	L2

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2.	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3.	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4.	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5.	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6.	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**				**1**	**1**
CO2	**2**	**2**	**2**	**2**	**2**	**1**
CO3	**2**			**2**	**2**	**2**
CO4	**3**			**2**	**3**	**3**

Semester- II

RAILWAY INFRASTRUCTURE PLANNING AND DESIGN [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Course Code	**22CTM242**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives: This course will enable students to
1. Describe the procedure of railway infrastructure planning.
2. Examine the factors governing planning and design of railway infrastructures.
3. Design the railway track system and signaling system.
4. Carryout railway tracks maintenance by advanced methods and apply remedial measures to ensure safety.

Module-1

Planning of railway network: Operational system, historical background, plans and developments, policy and standards, traffic forecasts and surveys, railway alignment, project appraisal and organization setups

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Component of railway track and rolling stock: Permanent way, forces acting on rails, function of rails, rail fixtures and fastenings, sleepers and ballast, rail joints, elements of junctions and layouts, types of traction, locomotives and other rolling stock, tractive effort and hauling power of locomotives.

Teaching-Learning Process	. Chalk and Talk/ Presentation/Assignment

Module-3

Geometric design of railway track, construction and maintenance:
Field investigation, right of way and formation, geometric design elements and standards, speeds computation, string lining of curves, grade compensation, railway cant and cant deficiency, traction, practice with examples. Special considerations and practices, track laying, inspection and maintenance, maintenance tools, maintenance of rail surface, track drainage, track circuited lengths, track tolerances, ballast confinement and track maintenance, renewal works.

Teaching-Learning Process	Chalk and Talk/ Presentation/Field studies

Module-4

Signalling and interlocking: Objectives, classifications, signaling systems, mechanical and electrical signaling systems, systems for controlling train movement, interlocking, and modern signaling.
Railway accidents and safety: Cause of train accidents, types of collision and derailment, restoration of traffic, safety measures, disaster management, level crossing and related accidents, remedial measures.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

Railway Station and Yards: Site selection, facilities, classification, platforms, building areas, types of yards, sidings, foot over bridges and subways, loading gauge, end loading ramps, locomotive sheds, triangles, buffer stop, scotch block, derailing switch, sand hump, fouling mark.
High Speed Railways: Modernization of railways, effect of high speed track, vehicle performance on track, high speed ground transportation system, ballast less track, elevated railways, underground, and tube railways.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Agarwal, M.M. Indian Railway Track, Prabha& Co., New Delhi, India, 1988.
2. Chandra S. and M. Agrawal, Railway Engineering, Second Edition, Oxford University Press, 2013.

Reference Books:

1. Clifford F. Bonnett, Practical Railway Engineering, 2nd edition, imperial college press, London, 2005.
2. Gupta, B.L. Text Book of Railway Engineering, Standard Publishers, New Delhi, India, 1982.
3. Mundrey, J. S., Railway Track Engineering, Fourth Edition, TATA McGraw- Hill, New Delhi, 2009
4. Rangwala, S.C. Principles of Railway Engineering, Charotar Publishing House, Anand, India, 2009.
5. Saxena S.C. and S.P. Arora, A text book of Railway Engineering, DhanpatRai, 2010
6. https://nptel.ac.in/courses/105107123/
7. https://www.edx.org/course/railway-engineering-an-integral-approach-2

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/107/105107123/

Skill Development Activities Suggested

- Field studies on Railway tracks
- Assignment
- Quiz

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Acquires capability of choosing alignment and also design geometric aspects of railway system.	L3
CO2	Suggest and estimate the material quantity required for laying a railway track and also will be able to determine the hauling capacity of a locomotive.	L4
CO3	Design the geometrics of railways	L5
CO4	Analyse the railway accidents and suggest remedial measures	L4

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2.	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3.	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4.	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5.	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6.	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**				**2**	**2**
CO2	**2**				**2**	**1**
CO3		**3**			**2**	**1**
CO4	**3**				**3**	**3**

Semester- II

ENVIRONMENTAL IMPACT ASSESSMENT OF TRANSPORTATION PROJECTS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Course Code	**22CTM243**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

This course will enable students to

1. Explain the concepts of environmental impact assessment and apply in the projects.
2. List a n d define various indicators such as terres trial sub systems, Indicators aquatic subsystems, Socio-economic and able to Select various indicators for EIA studies.
3. Explain the impacts of transportation related components on environment
4. Explain and illustrate the methodologies for environmental impact assessment

Module-1

Introduction: Environment and its interaction with human activities – Environmental imbalances - Attributes, Impacts, Indicators and Measurements -Concept of Environmental Impact Assessment (EIA), Environmental Impact Statement, Objectives of EIA, Advantages and Limitations of EIA

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Environmental Indicators - Indicators for climate - Indicators for terrestrial subsystems - Indicators for aquatic subsystems - Selection of indicators – Socioeconomic indicators - Basic information - Indicators for economy – Social indicators - Indicators for health and nutrition - Cultural indicators - Selection of indicators.

Teaching-Learning Process	. Chalk and Talk/ Presentation/Assignment

Module-3

Environmental Impact Assessment For Transportation Projects: Basic Concepts, Objectives, Transportation Related Environmental Impacts –Vehicular Impacts – Safety & Capacity Impacts– Roadway Impacts – ConstructionImpacts, Environmental Impact Assessment – Environmental Impact Statement,Environment Audit, Typical case studies

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-4

Environmental Issues in Industrial Development: On-site and Off-site impacts during various stages of industrial development, Long term climatic changes, Greenhouse effect, Industrial effluents and their impact on natural cycle, Environmental impact of Highways, Mining and Energy development

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

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

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

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

Reference Books:

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

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/124/107/124107160/
- https://archive.nptel.ac.in/courses/105/107/105107217/

Skill Development Activities Suggested

- Assignments on EIA
- Quizz

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	To assess the appropriateenvironmental indicators for EIA	L5
CO2	To formulate Environmental Impact Assessment For Transportation Projects	L5
CO3	To understand the Environmental Issues in Industrial Development	L2

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2.	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3.	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4.	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5.	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6.	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1					**2**	**1**
CO2	**2**				**2**	**1**
CO2					**3**	**2**

Semester- II

REMOTE SENSING AND GIS IN TRANSPORT PLANNING [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Course Code	**22CTM244**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:
This course will enable students to
1. Explain the purpose of accurate mapping of all features under different spatial and temporal scales of all kinds of terrain and land under water bodies.
2. Discuss on the advantages of remote sensing compared to traditional surveying techniques in terms of time, accuracy and output.
3. Explain the purpose and methods of obtaining abstract data both spatial and temporally.
4. Illustrate the application of GIS and remote sensing in solving real world transportation problems.

Module-1

Introduction to remote sensing : Definition – Components of Remote Sensing– Energy, Sensor, Interacting Body –Active and Passive Remote Sensing –Platforms– Aerial and Space Platforms – Balloons, Helicopters, Aircraft and Satellites– Electromagnetic Radiation– EMR Spectrum.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Introduction to GIS : Basic Concept and Components – Hardware, Software –Data Spatial and non- spatial – Geo-referencing – Map Projection – Types of Projection –Simple Analysis – Data retrieval and querying.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-3

Data structures and analysis: Database – Raster and Vector data structures –Data storage – Run length, Chain and Block coding – Vector data storage –Topology – GIS Modeling - Raster and Vector data analysis – Buffering and overlaying techniques – Network Analysis – Spatial Analysis

Teaching-Learning Process	Chalk and Talk/ Presentation/Software

Module-4

Basic applications in transportation: Highway and Railway Alignment, location of transport terminals and roadside facilities, bus stops – Route optimization – Bus route rationalization – Accident analysis – Applications of Aerial Photography and Satellite Imageries.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

Advanced applications: GIS as an integration technology – Integration of GIS, GPS and Remote Sensing Techniques – Advanced Traveller Information System (ATIS) –Automatic Vehicle Location System (AVLS)

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

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

Reference Books:

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

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/103/105103193/
- https://archive.nptel.ac.in/courses/105/101/105101206/

Skill Development Activities Suggested

- Usage of Remote sensing and GIS tool
- Quizz
- Industry visit

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Choose the remote sensing image from different sensors, resolutions, spatial and temporal scales	L3
CO2	Explain and to comprehend large tracks of earth surface with less time and cost but more accuracy.	L2
CO3	Communicate to the common man his analysis of different problems developments, benefits by preparing different thematic maps.	L2
CO4	Apply GIS and remote sensing techniques in solving real world transportation problems.	L3

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2.	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3.	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4.	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5.	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6.	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**			**2**	**2**	**2**
CO2				**2**	**2**	
CO3	**1**			**2**	**2**	**1**
CO4	**3**			**3**	**2**	**2**

Semester- II

TRANSPORTATION NETWORKS AND OPTIMISATION
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Course Code	**22CTM245**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:
This course will enable students to
1. Apply different traffic assignment techniques.
2. Estimate Trip tables.
3. Determine network reliability.
4. Design transportation networks

Module-1

Transport Network Characteristics: Networks representation, Network equilibrium, Link and Cost Functions, Incidence matrices, Network capacity, Shortest path algorithm.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Optimality and Cost Functions: Matrix operations, Objective functions, Traffic representation, Junctions costs, Priority junctions, Signal controlled junctions.

Teaching-Learning Process	. Chalk and Talk/ Presentation/Assignment

Module-3

Assignment Techniques: User Equilibrium – Existence and Uniqueness, Deterministic user equilibrium assignment, Most Likely paths, Elastic demand, Time Dependent Networks, stochastic user equilibrium assignment, User Equilibrium with variable demand models, Space-time networks, Case Studies.

Teaching-Learning Process	

Module-4

Trip Table Estimation: Maximum entropy, Generalized least squares, Linear path flow estimations, Log-linear path-flow estimations, Time-dependent methods, Case Studies.
Network Reliability: Connectivity, Structure functions and reliability value, Heuristic methods, Travel time reliability; Considerations of sample size; experiment design for demand forecasting and transportation operations analysis.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

Network Design: Bi-level programming-Iterative design, Sensitivity based algorithm, Sensitivities of user equilibrium and stochastic user equilibrium methods. Combined trip distribution and assignment, Combined mode choice and assignment, discrete choice models, Application to route choice, Estimating OD matrices, Estimating demand functions, Theory of congestion pricing, Path flows and link flows, Path-based and origin-based methods.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Ahuja R., T. Magnanti, and J. Orlin. Network Flows; Prentice Hall, 1993.

Reference Books:

1. Michael Alexander Florian, Michel Gendreau, Patrice Marcotte. Transportation and network analysis: current trends: miscellanea in honor of Michael Florian; Springer Publisher, 2002.
2. Michael G.H. Bell and YasunoriLida. Transportation Network Analysis, J. Wiley Publishers, 1997.
3. Yosef Sheffi. Urban Transportation Networks: Equilibrium Analysis with Mathematical Programming Methods, Prentice Hall Publishers, 1985. (http://web.mit.edu/sheffi/www/selectedMedia/sheffi_urban_trans_networks.pdf)

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/105/105105208/
- https://archive.nptel.ac.in/courses/124/105/124105016/

Skill Development Activities Suggested

- Exposure to land use planning
- Field visits on urban network planning
- Assignments

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Use the different traffic assignment techniques	L3
CO2	Estimate Trip tables.	L2
CO3	Analyse the network reliability.	L4
CO4	Development of transportation networks	L3

Program Outcome of this course

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2.	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3.	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4.	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5.	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6.	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**			**2**	**2**	**1**
CO2	**2**			**2**	**2**	
CO3	**2**			**2**	**2**	**2**
CO4		**2**		**2**	**2**	**2**

Transportation Engineering Lab

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Course Code	**22CTML26**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	01:02:00	SEE Marks	50
Credits	2	Exam Hours	3

Course objectives:

- The objective of this course is to make students learn:
- Illustrate the application of software for analyzing traffic survey data.
- Evaluation of Pavement functional and structural condition
- Explain and illustrate generation of models for transportation planning
- Introduce the methods of designing geometry of highways using computer software

Sl.NO	Experiments
1	**ANALYSIS OF TRAFFIC SURVEYS:** Classified volume count survey: TVC and TMC, Speed studies, Highway capacity Estimation,Speed and delay studies: Moving car method,LOS study, Origin and destination studies,Environmental impact – Noise studies and vehicular emission measurement, Lighting studies, Delay studies, Headway and Gap-acceptance studies. PedestrianSurvey. Parking studies, Road Safety Audit. Usage of traffic simulation software like VISSIM, VISSUM etc.
2	**PAVMENT EVALUATION LAB:** Road inventory, Pavement Condition Studies, Skid Resistance Studies, Stone PolishingValue Studies Road Roughness MeasurementBenkelman Beam Deflection Studies, Camber board, Straight edge, Dynamic cone penetration test (DCPT), Light weight deflectometer (LWD), Pavement core drilling test and Sand patch test
	Demonstration Experiments (For CIE) if any
3	**HIGHWAY GEOMETRY:** Design of horizontal alignment, vertical alignment, generating cross section anddesign of intersections by using MX Road, Open roads, and CIVIL 3D.
4	**TRANSPORTATION PLANNING:** (Data will be provided to compute the following) Trip generation modellingMode choice/modal split problemsTrip assignment problems. Usage of software's like CUBE
5	**Introduction to Use of Software Related to Transportation Engineering:** PAVEMENT EVALUATION & ECONOMIC ANALYSIS PACKAGES:DAMA Package Ken layer & Ken slab Economic Analysis Package HDM – IV IIT PAVE TRAFFIC ENGINEERING PACKAGES: Signal Design TRANSIT SYNCRO ACCIDENT ANALYSIS PACKAGE TIME SERIES PACKAGE

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Examine and arrive at required output from traffic surveys
- Identify the adequacy of the pavement performance- functional and structural.
- Analyse and generate models for transportation planning.
- Design the geometry of highways.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40%of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

- User Manuals of various packages
- Relevant IRC publications
- C.S.Papacostas and P.D.Prevedouros “Transportation engineering & Planning”, PHI learning
- Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., `Highway Engineering’, NemChandandBros, Roorkee

III Semester-

Transport Planning [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Course Code	22CTM31	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:02:0	SEE Marks	50
Total Hours of Pedagogy	40 hours	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives: This course will enable students to

1. Recall basic concepts and methods of urban transportation planning in the India.
2. Summarize methods of designing, conducting and administering surveys to provide the data required for transportation planning.
3. Examine and apply travel demand modelling, Mode Choice Modelling and Traffic Assignment Modelling.

Module-1

Urban Transportation Problems and Policy:
Urban transportation Issues, Travel Characteristics, Evolution of Planning Process, Supply and Demand – Systems approach; NUTP, Recommendations of 12th FYP and NTDP; Smart Cities, Service Level Benchmarks.

Travel Demand Approaches:
Trends, Overall Planning process, Long term Vs. Short-term planning, Types of Plans, Master Plans, Demand Function, Independent Variables, Travel Attributes, Assumptions in Demand Estimation, Sequential, and Simultaneous Approaches, Aggregate and Disaggregate Techniques, UTPS Approach.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Data Collection and Inventories:
Collection of data – Organisation of surveys and Analysis, Study Area, Zoning, Types, and Sources of Data, Road Side Interviews, Home Interview Surveys, Commercial Vehicle Surveys, Sampling Techniques, Expansion Factors, Accuracy Checks, Use of Secondary Sources, Economic data – Income – Population – Employment – Vehicle Owner Ship.

Teaching-Learning Process	. Chalk and Talk/ Presentation/Assignment

Module-3

Trip Generation:
Trip Generation Analysis: Zonal Models, Category Analysis, Household Models, Trip Attraction models, Commercial Trip Rates.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-4

Trip Distribution:
Trip Distribution: Growth Factor Methods, Gravity Models, Opportunity Models, Time Function Iteration Models.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

Mode Split:
Mode Choice Behaviour, Competing Modes, Mode Split Curves, Models, and Probabilistic Approaches

Traffic Assignment:
Traffic Assignment: Basic Elements of Transport Networks, Coding, Route Properties, Path Building Criteria, Skimming Tree, All-or-Nothing Assignment, Capacity Restraint Techniques, Reallocation of Assigned Volumes, Equilibrium Assignment, Diversion Curves.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. 1. **Kadiyali, L. R.**, `Traffic Engineering and Transportation Planning' - Khanna Publication, New Delhi, 2009
2. **JotinKhisty and B. Kent Lall "** Transportation Engineering –An Introduction- PHI, New Delhi, 3rd Indian Edition, 2006.
3. **Hutchinson**, B.G., `Principles of Urban Transport System Planning' - McGraw Hill Book Co., London, UK, 1982.
4. **Institute of Traffic Engineers** - An Introduction to Highway Transportation Engineering 'New York., 1982

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/105/105105208/
- https://archive.nptel.ac.in/courses/105/107/105107067/
- https://archive.nptel.ac.in/courses/105/106/105106058/
- https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-252j-urbantransportation-
- planning-fall-2016/
- https://olc.worldbank.org/content/integrated-urban-transport-planning-self-paced

Skill Development Activities Suggested

- Usage of software tools like cube
- Excel analysis
- Assignment

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Identify urban transportation problems and Develop data base for calibration of travel demand models.	L2
CO2	Estimate urban travel demand.	L4
CO3	Plan urban transport networks.	L4

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2			2	2	1
CO2	2			2	2	1
CO3	3	3	3	3	3	2

III Semester-

Rural roads [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Course Code	22CTM321	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:02:0	SEE Marks	50
Total Hours of Pedagogy	40hours	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: This course will enable students to
1. To understand the factors affecting pavement design and performance of Rural Roads.
2. To relate the concepts of Highway Geometric design to that of Rural roads
3. To design the Special pavements which form alternatives for RuralRoads.
4. To understand the concepts of design of drainage, CD works and small bridges which form essential structures of Rural roads

Module-1

Low Volume Road Network Planning:
Significance, definition, characteristics of LVRs, terminology used in LVRs, PMGSY, development of LVRs in India, rural roads vision 2025, international scenario of LVRs developments, Master plan and core network concepts, network planning of LVRs and models, detailed project report preparation, environmental issues, and GIS-based rural road network planning.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Geometric Design of LVRs:
Topography and physical features, traffic, geometric design standards for LVRs with particular reference to PMGSY, Hill Road standards, design concepts and criteria, cross-sectional elements, CD works, horizontal alignment, vertical alignment, and traffic engineering requirements, international recommendations, experience, and various countries standards on LVRs geometric designs and case studies.

Teaching-Learning Process	. Chalk and Talk/ Presentation/Field visit

Module-3

Marginal and New Materials:
Overview of conventional materials, waste materials, source of marginal materials, guidelines, subgrade stabilization, dealing with poor subgrades, framework for appropriate use of marginal materials, new technologies and their design aspects, Geosynthetic applications, functions, and design methods.

Teaching-Learning Process	Chalk and Talk/ Presentation/Field visit

Module-4

Pavement Design of LVRs:
LVR design principles, vehicle classifications, traffic volumes, ESALs per vehicle class, design traffic classes, pavement design methods for LVRs, empirical approaches, AUSTROADS pavement, AASHTO, US MEPDG, flexible and rigid pavement using IRC methods, and gravel road design in the Indian context.

Teaching-Learning Process	Chalk and Talk/ Presentation/Field visit

Module-5

Construction and Specifications of LVRs:
Conventional construction methods, specifications, new technologies, construction methods and benefits, case studies, low-cost construction techniques, quality control and assurance mechanism, and MoRD specifications.

Teaching-Learning Process	Chalk and Talk/ Presentation/Field visit

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

4. Three Unit Tests each of **20 Marks**
5. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
6. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

6. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
7. The question paper will have ten full questions carrying equal marks.
8. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
9. Each full question will have a sub-question covering all the topics under a module.
10. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A.,`Highway Materials and PavementTesting", NemChand and Bros, Roorkee

Reference Books:

1. IRC SP 20 Rural Roads Manual Ministry of Rural Road Development
2. HMSO, "Soil Mechanics for Road Engineers", Her Majesty"s Stationary Office, London.
3. IRC, Manual for Rural Roads, Indian Road Congress, 2002.
4. Relevant IRC Codes & Publications.
5. PIARC, International Road Maintenance Hand Book –Maintenance of Paved Roads, France.
6. PIARC, International Road Maintenance hand Book –Maintenance of Unpaved Roads, France

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/106/105106188/

Skill Development Activities Suggested

- Field visit
- Assignment
- Pavement design in excel

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Plan low-volume road network.	L4
CO2	Design low volume road geometrics	L5
CO3	Identify appropriate materials and cost-effective technologies for LVRs.	L2
CO4	Analyze and design flexible and rigid pavements for LVRs.	L5
CO5	Select an appropriate pavement construction technique and perform quality control tests.	L4

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**				**2**	
CO2		**3**		**3**	**2**	**2**
CO3	**2**		**2**		**2**	
CO4		**3**		**2**	**2**	**2**
CO5	**2**				**2**	**2**

Semester- III

ROAD ASSET MANAGEMENT [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Course Code	**22CTM322**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	**03:0:0**	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives: This course will enable students to
1. Value the principles and concepts of asset management.
2. Develop Highway Inventory systems.
3. Develop Financial Management and workforce management systems
4. Develop Construction Management and Safety Management Systems.
5. Develop Bridge Management System.
6. Develop Pavement Management & Highway Maintenance Management Systems

Module-1	
Highway Asset Management: Principles, types of asset management definition, structure, historical background, elements of highway asset management, asset Inventory, activity and cost model development, public assets versus private assets, motivation for asset management, benefits of road asset, management system, financial management systems, roads billing, roads payment and cost accounting and tools for asset management.	
Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2	
Highway Asset Valuation and Frame Work: Asset Valuation approaches, guidelines, overview of highway asset valuation procedure, valuation principles, basis and rules, depreciation, highway lighting and high mast lighting, land associated with the highways	
Teaching-Learning Process	. Chalk and Talk/ Presentation/Assignment

Module-3	
Construction Management Systems: Preconstruction scheduling, utility management, ROW management, user occupancy permits, project control, agreement monitoring and contractor management.	
Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-4	
Roadway Operations Management Systems: Joint operations center, district operations center, traveler informationsystems.	
Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5	
Road Asset Management Modules: Bridge inventory and rating, bridge management, Workforce Management Systems, Payroll detail, personal information and employee accident. Safety Management Systems Accident records, hazardous location and highway safety information Equipment Management Systems Equipment management information, fleet management	
Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. AASHTO Transportation Asset Management Guide: A Focus on Implementation,AASHTO, 2011.
2. Hamilton, W.E. Transportation: Asset Management, House Fiscal Agency, 2001.
3. NCHRP Report 551. Performance Measures and Targets for Transportation AssetManagement, TRB, 2006.

Reference Books:

1. NCHRP Report 632. An Asset-Management Framework for the Inter State Highways,TRB, 2009.
2. NCHRP Synthesis 439. Use of Transportation Asset Management Principles in StateHighway Agencies, TRB, 2013.
3. NHS. Transportation Asset Management, Federal Highway Administration, National Highway Institute, USA, 2003.
4. OECD. Asset Management for the Roads Sector, Organization for Economic Cooperationand Development, France, 2001.
5. Thompson, P.D. AASHTO Transportation Asset Management Guide: A Focus on Implementation, USA, 2011.
6. Transportation Association of Canada, "Pavement Asset Design and ManagementGuide, December, 2013.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=ep3j7f_LuM
- https://www.piarc.org/en/

Skill Development Activities Suggested

- Case studies of road asset management system
- Assignment
- Quiz

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Value the principles and concepts of asset management.	L1
CO2	Develop Highway Inventory systems.	L4
CO3	Develop Financial Management and work force management systems	L4
CO4	Develop Pavement Management & Highway Maintenance Management Systems.	L4

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**			**2**	**2**	**2**
CO2	**2**				**2**	**2**
CO3	**2**			**2**	**2**	**2**
CO4	**2**			**2**	**2**	**2**

Semester- III

INTELLIGENT TRANSPORTATION SYSTEMS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Course Code	**22CTM323**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:
This course will enable students to
1. Have an awareness and scope of transport issues, such as, traffic safety, public transport, advanced vehicle management and control.
2. Learn how Intelligent transport systems (ITS) involve the application of information technology and telecommunications to control traffic, inform travelers and drivers, operate public transport, automating payments, handle emergencies and incidents, operate commercial fleets and freight exchange, and automate driving and safety.

Module-1

Basic elements of intelligent transportation systems (ITS), focusing on technological,systems and institutional aspects.Benefits of ITS -ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Advanced traveller information systems; transportation network operations; commercial vehicle operations and intermodal freight;

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-3

Public transportation applications: ITS and regional strategic transportation planning, including regional architectures

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-4

ITS and changing transportation institutions, ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS and sustainable mobility,

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

Travel demand management, electronic toll collection, and ITS and road-pricing. Automated Highway Systems- Vehicles in Platoons –ITS in World – Overview of ITS implementations in developed countries, ITS in developing countries.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Book:

1. Choudury M A and Sadek A, "Fundamentals of Intelligent Transportation Systems Planning" Artech House.

Reference Books:

1. Kan Paul Chen, John Miles, "Recommendations for World Road Association (PIARC)" ITS Hand Book 2000.
2. Sussman, J. M., "Perspective on ITS", Artech House Publishers, 2005.
3. US Department of Transportation, "National ITS Architecture Documentation", 2007 (CDROM).
4. Turban. E and Aronson. J. E, "Decision Support Sys tems and Intelligent Systems", Prentice Hall

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/101/105101008/
- https://www.its.dot.gov/factsheets/benefits_factsheet.htm

Skill Development Activities Suggested

- Visit to smart city office
- Assignments

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Would be able to amalgamate the various systems, plan and implement the applications of ITS.	L3
CO2	Would have learnt the application of information technology and telecommunication to control traffic and also provide advance information to the travelers, automatic handling of emergencies and to improve safety.	L3

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**			**2**		**1**
CO2	**2**			**2**		**1**

Semester- III

TRANSPORT ECONOMICS AND PROJECT APPRAISAL [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Course Code	**22CTM324**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives: This course will enable students to
1. Differentiate macro and micro economic principles
2. Quantify benefits and costs of transport projects and carryout economic analysis
3. Evaluate transport projects
4. Analyse life cycle cost of a transport projects
5. Appreciate private sector participation in transportation industry

Module-1

Transport Economics: Review of Engineering Economics and Microeconomics, Welfare Theory and Equilibrium Conditions, Goals and Objectives, Principles of Economic Analysis

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Methods of Economic Analysis: Discounted Cash Flows: Analysis of User Costs and Benefits, RUCS Models for Costs and Benefits, Methods of Economic Analysis; Suitability, Analysis for Null Alternativ

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-3

System Selection and Evaluation: Framework of Evaluation, Transport Planning Evaluation at Urban and Regional levels, Other Evaluation Procedures – Traditional Economic Analysis, Achievement Matrices, Factor Profiles, Plan Ranking, Introduction to Mathematical Programming, Bidding Games, Delhi Technique, Multi- Criteria Evaluation, Case Studies.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-4

Life Cycle Cost Analysis: Factors consider for Life Cycle Cost Analysis; Data requirements for highway project feasibility analysis, establishment of Technical/ Economic/ Financial feasibility of a highway project, Social Benefits, Role of HDM in feasibility studies.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

Project Appraisal – Private Sector Participation: BOT, BOOT, BOLT Projects –Case history– Project Planning – Project System Management – Project Implementation – Funds Planning –Budgetary and Control – Tendering and Contract – Value Analysis, Information System - Impact assessment, Project Report
Preparation.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. C.G. Swaminathan and L.R. Kadiyali, Road User Cost Study in India, Central Road Research Institute, New Delhi, 1983.
2. CRRI, Updation of Road User Study Data and Road User Costs, CRRI, 2012

Reference Books:

1. Highway investment in Developing countries; Commission of the European Communities, Institute of Civil Engineers, Thomas Telford Ltd 1983.
2. John W. Dickey and Leon H. Miller, Road Project Appraisal for Developing countries, John Wiley and Sons., 1984.
3. L.R. Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, 2012.
4. Michael J Markow, Engineering Economic Analysis Practices for Highway Investment, NCHRP Synthesis 424, TRB, 2012
5. Robley Winfrey, Economic Analysis for Highways - International Text Book Co., Pennsylvania, 1969.
6. VinayMaitri and P.K Sarkar, Thory and Applications of Economics in Highway and Transport Planning, Standard Publishers Distributors, First Edition 2010.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/103/105103023/
- https://archive.nptel.ac.in/courses/105/104/105104098/

Skill Development Activities Suggested

- Assignment
- Case studies on transport economics

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Solve the problems of macro and micro economic principles	L3
CO2	Analyse the benefits and costs of transport projects and carryout economic analysis	L4
CO3	Analyse and Evaluate transport projects	L4
CO4	Calculate the life cycle cost of a transport projects	L3
CO5	Analyse private sector participation in transportation industry	L4

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**				**2**	
CO2	**2**			**2**	**2**	**2**
CO3	**2**			**2**	**2**	**2**
CO4	**2**			**2**	**2**	**2**
CO5	**2**			**2**	**2**	**2**

Semester- III

ADVANCED TRAVEL DEMAND MODELLING [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Course Code	**22CTM325**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:03	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives: This course will enable students to
1. Develop discrete choice models.
2. Develop travel demand models using Stated Preference data.
3. Estimate Travel Demand using activity based analysis.
4. Assess Qualitative Variables.
5. Test model aggregation and transferability.
6. Develop Travel Demand Models for small cities using Quick response

Module-1

Discrete Choice Analysis: Utility Concept; Mode choice; Logit Models; Do git Model; Nested Logit Model; Pro bit Model; Route Choice Modelling; Combined Travel Demand Modelling; Model Parameter Estimation – Maximum Likelihood and Maximum Entropy Estimates.

Stated Preference Methods:
Stated preference vs. Revealed Preferences; Design Issues; Survey Methods, Conjoint Analysis; Functional Measurement; Trade off Analysis, Transfer Price Method

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Activity Based Travel Demand Models: Activity patterns; Activity scheduling; Activity Time Allocation studies; Activity Episode Analysis; Travel Duration Analysis

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-3

Qualitative Variables: Role of Soft variables in Travel Demand Forecasting; Attitudes; Psychometric scaling Techniques – One-dimensional Scaling –Multidimensional Scaling; Basic Rating Scales: Comparative Rating Scales, Non –Comparative Rating scale, Itemised rating scale, graphic rating scale; Specific Attitude scales; Successive Categories; Principal Components Factor Analysis; Attitudinal Models

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-4

Model Aggregation and Model Transferability: Aggregation bias and forecasting; Aggregation Methods; Temporal Stability and geographical stability of Models; Transfer Model Updating Procedures –Transferring with Aggregate and Disaggregate sample data; Transferability Measures.

Simplified Travel Demand Models: Sketch planning Methods; Incremental Demand Models; Model estimation from traffic Counts; IVF Models, Marginal and Corridor Models; Gaming Simulation, Quick Response Techniques.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

Introduction to Advanced Modeling Techniques: GO Models; Entropy Models; Equilibrium Assignment Techniques, MultipathAssignment – Dial‟s Algorithm, Knowledge Based Expert System; Neuro –Fuzzy
Application; ANN Techniques; Genetic Algorithms; Object Oriented Programming; Decision Support Systems; Goal Programming.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Alan Geoffrey Wilson. Optimisation in Location and Transport Analysis, John Wiley & Sons, 1981 (Digitized: 31 March 2011).
2. Harry Timmermans, *Progress in Activity Based Analysis*, Elsevier Science, 2005

Reference Books:

1. Joe Castiglione, Mark Bradley and John Gliebe, Activity-Based Travel Demand Models: A Primer, TRB, Washington, D.C., 2015
2. Juan de Dios Ortuzar and Luis G. Willumsen, *Modelling Transport, 4th Edition*, John Wiley and Sons, 2011.
3. Laurie A. Garrow, Discrete Choice Modelling and Air Travel Demand: Theory and Applications, Routledge, 2010
4. Moshe Ben-Akiva, and Steven R. Lerman, *Discrete Choice Analysis: Theory and Application to Travel Demand*, The MIT Press, Paperback 2018.
5. Norbert Oppenheim, *Urban Travel Demand Modelling: From Individual Choices to general Equilibrium*, John Wiley and Sons, Inc., 1995 (Digitized 29 June 2011).
6. Time use Analysis, Special Issue, Transportation, 26, Kluwer Academic Publishers, 1999.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/105/105105208/
- https://archive.nptel.ac.in/courses/105/107/105107067/
- https://archive.nptel.ac.in/courses/105/106/105106058/

Skill Development Activities Suggested

- Exposure to planning software's like TransCAD and CUBE
- Assignment

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Develop discrete choice models.	L3
CO2	Develop travel demand models using Stated Preference data.	L3
CO3	Estimate Travel Demand using activity based analysis.	L4
CO4	Assess Qualitative Variables.	L5
CO5	Develop Travel Demand Models for small cities using Quick response	L3

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2.	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3.	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4.	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5.	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6.	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**			**2**	**2**	**2**
CO2	**2**			**2**	**2**	**2**
CO3	**2**			**2**	**2**	**2**
CO4	**2**			**2**	**2**	**1**
CO5	**2**			**2**	**2**	**2**

Semester- III

ROAD SAFETY AND MANAGEMENT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	22CTM331	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

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

Module-1

Road accidents, Causes, Scientific Investigations and Data Collection: Analysis of Individual accidents to arrive at Real Causes, Statistical Methods of Analysis of Accident Data,Application of Computer Analysis of Accident Data.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Ensuring Traffic Safety in Designing New Roads: Meteorological Conditions, Structure of Traffic Streams, Orientation of a Driver on the Direction of a Road beyond the Limits of Actual Visibility and Roadway Cross Section & Objects on the Right-of-Way.

Teaching-Learning Process	Chalk and Talk/ Presentation/Software's

Module-3

Ensuring Traffic Safety in Road Reconstruction: Road Reconstruction and Traffic Safety, Reconstruction Principles, Plotting of Speed Diagram for Working out Reconstruction Projects, Use of Accident Data in Planning Reconstruction of Roads, Examples of Reconstruction of Selected Road Sections for Improving Traffic Safety, Improving Traffic Conditions on Grades, Sharp Curves, Redesign of Intersections, Channelized At-Grade Intersections, Bus Stops, Parking& Rest Areas and Effectiveness of Minor Road Improvements.

Teaching-Learning Process	Chalk and Talk/ Presentation/ Software's

Module-4

Ensuring Traffic Safety in Road Operation: Ensuring Traffic Safety during Repair and Maintenance, Prevention of Slipperiness and Influence of Pavement Smoothness, Restriction speeds on Roads, Safety of Pedestrians, Cycle Paths, Informing Drivers on Road Conditions with Aid of Signs, Traffic Control Lines &Guide Posts, Guardrails& Barriers and Road Lighting.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

Road Safety AuditandTrafficManagementTechniques:Principles- Procedures and Practice, Code of Good Practice and Checklists. Road safety issues and engineering, education, enforcement measures for improving road safety. Local area management, Various types of long-term traffic management measures and their uses. Evaluation of the effectiveness and benefits of different traffic management measures, management and safety practices during road works.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. BABKOV, V.F. `Road conditions and Traffic Safety', MIR, publications,Mascow - 1975.
2. K.W. Ogden, `Safer Roads – A Guide to Road Safety Engg.' Averbury Technical, Ashgate Publishing Ltd., Aldershot, England, 1996.
3. Kadiyali, L.R., `Traffic Engineering and Transport Planning', Khanna Publications, New Delhi, 2009.
4. C. JotinKishty& B. Kent Lall, "Transportation Engineering-An Introduction", Thrid Edition, Prentice Hall of India Private Limited, New Delhi, 2006
5. Latest Editions of Relevant Indian Roads Congress (IRC) Publications for Design of Roads and Road Safety.
6. Khanna and Justo, 'Text book of Highway Engineering', Nemchand Brothers, Roorkee,2001.

Skill Development Activities Suggested

- Usage of software applications
- Excel analysis
- Assignment

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Able to acquire knowledge statistical methods and computer application of accident analysis.	L1
CO2	Capable of analysing the factors affecting the construction of new roads. 3.	L4
CO3	Capable of analysing the factors affecting the reconstruction of existing roads.	L4
CO4	Capable of analysing the factors affecting the operation condition of road.	L4
C05	Able to remember the process of road safety audit and the measures of improving road safety	L1
C06	Qualified to evaluate the effectiveness of various management techniques adopted in reducing road accident	L3

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2.	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3.	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4.	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5.	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6.	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**			**1**		**1**
CO2	**2**			**2**		**2**
CO3	**2**			**2**		**2**

Semester- III

Rheology of Materials

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	22CTM332	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- **To understand the applications of rheology**
- **To model the materials by using rheological principles**

Module-1

Flow phenomena in complex materials and microstructure; Complex materials; Applications of rheology, with some example material systems. Stress, strain rate, velocity gradient; Kinematics for simple flows

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Rheometric flows; Rheometers â€“ general review, Tensors and index notation; Viscous fluids; Stress relaxation

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-3

Maxwell model; Oscillatory shear, Relaxation time spectrum; Generalized Maxwell model; Time temperature superposition; Solid like materials

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-4

General linear viscoelastic material â€“ linear response; Review of material functions, Survey â€“ polymers; Survey â€“ glass-rubber transition, Survey â€– multiphase systems; Experimental artifacts â€– fluid mechanics of cone plate geometry

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

Strain and convected rate; Normal stress, stress growth, Yield stress fluids â€“ Hershel Belkley model, thixotropic fluids â€– Structural MODEL, erms in nonlinear models; Microscopic origin of stress

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Rheology of complex materials by Abhijith Deshpande
2. Rheology: Concepts, Methods, and Applications by AY Malkin

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/103/106/103106131/

Skill Development Activities Suggested

- DSR equipment will demonstrated
- Brookfield viscometer demonstration

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	• **To understand the applications of rheology**	L2
CO2	• **To model the materials by using rheological principles**	L4

Program Outcome of this course
Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**					**1**
CO2			**2**			**2**

Semester- III

Optimization Methods for Civil Engineering			
Course Code	22CTM333	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3+0+0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

This course will enable students to;

1. Understand various optimization techniques for the transport network.
2. Evaluate an LP model for the transportation problem.
3. Analyze multicriteria optimization for optimality
4. Apply different inventory methods to optimize logistics distribution.

Module-1

Basics of Optimization:

General methods for operation research models; introduction to linear and non-linearprogramming formulation of different models.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Linear Programming (LP) in Transportation:

Introduction to LP and formulation of linear programming problems, graphical solutionmethod, alternative or multiple optimal solutions, unbounded solutions, infeasible solutions,maximization – simplex algorithms.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-3

Duality Theory:

Primal vs. dual formulations, duality theory, complementary slackness, and sensitivityanalysis.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-4

Mathematical Optimization:

Optimality criteria for the Unconstrained Problems,Optimality Criteria for the ConstrainedProblems, Optimality Criteria for General Optimization Problems, Postoptimality Analysis;Multicriteria Optimization, Optimization on Fuzzy Sets.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

Inventory Models and Transportation Problem:

Introduction to inventory control, deterministic inventory model, EOQ model with a quantitydiscount, initial basic feasible solutions of balanced and unbalancedtransportation/assignment problems, optimal solutions.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
3. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Engineering Optimization Theory and Practice, Rao, S.S., Wiley Publisher, 2019, FifthEdition.
2. Sustainable Logistics and Transportation: Optimization Models and Algorithms, Cinar, D., Gakis, K., Pardalos, P.M., Springer ,2017 ,First Edition.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112/106/112106134/
- https://archive.nptel.ac.in/courses/105/103/105103210/
- https://sboyles.github.io/teaching/ce367

Skill Development Activities Suggested

- Software analysis
- Assignment

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Differentiate various optimization techniques for the transport network.	L2
CO2	Formulate an LP model for the transportation problem.	L5
CO3	Analyze multicriteria optimization for optimality	L4
CO4	Apply different inventory methods to optimize logistics distribution	L3

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**				**1**	
CO2	**2**					
CO3				**2**	**3**	**1**
CO4				**2**	**3**	**2**

Semester- III

Numerical Methods in Civil Engineering			
Course Code	**22CTM334**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3+0+0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

1. To introduce numerical methods to solve different types of equations.
2. To introduce interpolation techniques.
3. To know various methods of Differentiation & Integration.
4. To apply the knowledge of these methods to solve practical problems.

Module-1

Roots of Equation and Solution of algebraic and transcendental equations.
Bisection Method ,Fixed point iteration method, Newton Raphson method.
Solution of linear system of equations, Gauss elimination method, Pivoting, Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Matrix Inversion by Gauss Jordan method.
Implementation using Matlab

Teaching-Learning Process	Chalk and Talk/ Presentation/Software

Module-2

Interpolation and Approximation: Interpolation with unequal intervals - Lagrange's interpolation – Newton's divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton's forward and backward difference formulae. Implementation using Matlab

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-3

Numerical Differentiation and Integration: Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule – Romberg's method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-4

Initial Value Problems for Ordinary Differential Equations : Single Step methods - Taylor's series method - Euler's method - Modified Euler's method – Fourth order Runge-Kutta method for solving first order equations - Multi step methods - Milne's and Adams-Bash forth predictor corrector methods for solving first order equations.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

Boundary Value Problems in Ordinary and Partial Differential Equations: Finite difference methods for solving two-point linear boundary value problems - Finite difference techniques for the solution of two-dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

4. Three Unit Tests each of **20 Marks**
5. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
6. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

6. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
7. The question paper will have ten full questions carrying equal marks.
8. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
9. Each full question will have a sub-question covering all the topics under a module.
10. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Higher Engineering Mathematics", Dr. B. S. Grewal, Khanna Publishers, New Delhi, 7th Edition, 2005.
2. "Numerical Methods", Dr. B.S. Grewal, Khanna Publishers, New Delhi, 7th Edition, 2005.
3. "Numerical Methods", E Balguruswamy Tata McGraw-Hill Publication Company Ltd. 8th Edition, 2002.
4. "Numerical Methods", S. Arumugam, A. Thangapandi Isaac and A.Somasundaram, SciTech Publications India Pvt. Ltd. Chennai, 2nd Edition, 2007.
5. "Numerical Methods", Dr. P. Kandasamy, Dr. K. Gunavathi, Dr. K. Thilagavathy. S Chand Publication, New Delhi, 2nd Edition, 2006
6. "Numerical Methods", G. Haribaskaran, Laxmi Publications Pvt. Ltd, New Delhi, 1st Edition, 2006.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/111107105
- https://www.coursera.org/learn/numerical-methods-engineers
- https://cosmolearning.org/courses/numerical-methods-and-programing/video-lectures/

Skill Development Activities Suggested

- Assignments to implement numerical methods in Matlab to solve practical problems.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand and apply various methods to find roots of equations	L3
CO2	Learn and Implement different methods to solve simultaneous equations.	L3
CO3	Understand and apply the methods of interpolation	L3
CO4	Implement various numerical methods for differentiation and Integration	L3
CO5	Apply various methods to solve engineering problems with Ordinary differential equations.	L3

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	3Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**			**2**		
CO2	**1**			**2**		
CO3	**1**					
CO4	**1**					
CO5	**1**					

Semester- III

Finite Element Analysis			
Course Code	22CTM335	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3+0+0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

This course will enable students to;

1. Develop analytical skills.
2. Learn principles of analysis of stress and strain.
3. Develop problem solving skills.
4. Understand the principles of FEM for one and two dimensional problems.

Module-1

Theory of elasticity concepts, Energy principles, Rayleigh - Ritz Method, Galerkin method and finite element method, steps in finite element analysis, displacement approach, stiffness matrix and boundary conditions.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-2

Discritisation; finite representation of infinite bodies and discritisation of very large bodies, Natural Coordinates, Shape functions; polynomial, LaGrange and Serendipity , one dimensional formulations; beam and truss with numerical examples.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-3

2D formulations; Constant Strain Triangle, Linear Strain Triangle, 4 and 8 noded quadrilateral elements, Numerical Evaluation of Element Stiffness -Computation of Stresses, Static Condensation of nodes, degradation technique, Axisym metric Element.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-4

Isopara metric concepts; is opera metric, sub parametric and super parametric elements, Jacobian transformation matrix, Stiffness Matrix of Isopara metric Elements, Numerical integration by Gaussian quadrature rule for one, two and three dimensional problems.

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Module-5

Techniques to solve nonlinearities in structural systems; material, geometric and combined non linearity, incremental and iterative techniques. Structure of computer program for FEM analysis, description of different modules, exposure to FEM software's

Teaching-Learning Process	Chalk and Talk/ Presentation/Assignment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

7. Three Unit Tests each of **20 Marks**
8. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs
9. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

11. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
12. The question paper will have ten full questions carrying equal marks.
13. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
14. Each full question will have a sub-question covering all the topics under a module.
15. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Krishnamurthy C.S., "Finite Element analysis" -Tata McGraw Hill
2. Desai C &Abel J F.," Introduction to Finite element Method" , East West Press Pvt. Ltd.,
3. Cook R D et.al. "Concepts and applications of Finite Element analysis", John Wiley.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/112/105/112105308/
- https://archive.nptel.ac.in/courses/105/108/105108141/

Skill Development Activities Suggested

- Software analysis
- Assignment

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Develop analytical skills.	L3
CO2	Understand the principles of analysis of stress and strain.	L3
CO3	Develop problem solving skills in any materials	L3
CO4	Understand the principles of FEM for one and two dimensional problems.	L3

Program Outcome of this course

Sl. No.	Description	POs
1	Apply the knowledge of Transportation Engineering to identify, evaluate and analyze complex Engineering problems	PO1
2	Design solution for Transportation Engineering problems and design system components with appropriate consideration for societal environment and safety aspects.	PO2
3	3Conduct research investigations through literature survey and experiments to analyze and interpretation of data to provide valid conclusions.	PO3
4	Use appropriate modern tools and techniques such as open roads, Civil 3D, IIT Pave and VISSIM etc., for design, prediction and modelling of Transportation Engineering activities	PO4
5	Understand the impact of transportation engineering solution in societal and environmental context by acquiring professional codal knowledge, ethics for sustainable development of community.	PO5
6	Apply the knowledge of Transportation engineering to one's research work to manage multidisciplinary projects in Transportation sector and posses lifelong learning skills in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**			**2**	**2**	**1**
CO2	**2**				**1**	**1**
CO3	**1**			**2**	**2**	**1**
CO4	**2**				**1**	**1**

PROJECT WORK PHASE – 1			
Course Code	22CTM34	CIE Marks	100
Number of contact Hours/Week	00:06:00	SEE Marks	--
Credits	03	Exam Hours	--

Course objectives:

- Support independentlearning.
- Guide to select and utilize adequate information from varied resources maintainingethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentationskills.
- Impart flexibility andadaptability.
- Inspire independent and teamworking.
- Expand intellectual capacity, credibility, judgement,intuition.
- Adhere to punctuality, setting and meetingdeadlines.
- Instil responsibilities to oneself andothers.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchangeideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power pointslides.
- Answer the queries and involve indebate/discussion.
- Submit two copies of the typed report with a list ofreferences.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

At the end of the course the student will be able to:

- Demonstrate a sound technical knowledge of their selected projecttopic.
- Undertake problem identification, formulation, andsolution.
- Design engineering solutions to complex problems utilising a systemsapproach.
- Communicate with engineers and the community at large in written an oralforms.
- Demonstrate the knowledge, skills and attitudes of a professionalengineer.

SOCIETAL PROJECT			
Course Code	22CHT35	CIE Marks	100
Number of contact Hours/Week	00:06:00	SEE Marks	--
Credits	03	Exam Hours	--

Course objectives:

- Support independentlearning.
- Guide to select and utilize adequate information from varied resources maintainingethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentationskills.
- Impart flexibility andadaptability.
- Inspire independent and teamworking.
- Expand intellectual capacity, credibility, judgement,intuition.
- Adhere to punctuality, setting and meetingdeadlines.
- Instil responsibilities to oneself andothers.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchangeideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the societal Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected societal project orally and/or through power pointslides.
- Answer the queries and involve indebate/discussion.
- Submit two copies of the typed report with a list ofreferences.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

At the end of the course the student will be able to:

- Demonstrate a sound technical knowledge of their selected societal projecttopic.
- Undertake problem identification, formulation, andsolution.
- Design engineering solutions to complex problems utilising a systemsapproach.
- Communicate with engineers and the community at large in written an oralforms.
- Demonstrate the knowledge, skills and attitudes of a professionalengineer.

Semester

INTERNSHIP			
Course Code	22CTMI36	CIE Marks	50
Number of contact Hours	06 Weeks	SEE Marks	50
Credits	06	Exam Hours	03

Course objectives:

Internship provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

- To put theory intopractice.
- To expand thinking and broaden the knowledge and skills acquired through course work in thefield.
- To relate to, interact with, and learn from current professionals in thefield.
- To gain a greater understanding of the duties and responsibilities of aprofessional.
- To understand and adhere to professional standards in thefield.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, andconfidentiality.
- To identify personal strengths andweaknesses.
- To develop the initiative and motivation to be a self-starter and workindependently.

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power pointslides.
- Answer the queries and involve indebate/discussion.
- Submit the report duly certified by the externalguide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and becomeself-confident.

Course outcomes:

At the end of the course the student will be able to:

- Gain practical experience within industry in which the internship isdone.
- Acquire knowledge of the industry in which the internship isdone.
- Apply knowledge and skills learned to classroomwork.
- Develop a greater understanding about career options while more clearly defining personal careergoals.
- Experience the activities and functions ofprofessionals.
- Develop and refine oral and written communicationskills.
- Identify areas for future knowledge and skilldevelopment.
- Expand intellectual capacity, credibility, judgment,intuition.
- Acquire the knowledge of administration, marketing, finance andeconomics.

Semester

PROJECT WORK PHASE -2			
Course Code	22CTM41	CIE Marks	100
Number of contact Hours/Week(L:P:S)	00:08:00	SEE Marks	100
Credits	18	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintainingethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentationskills.
- To impart flexibility andadaptability.
- To inspire independent and teamworking.
- To expand intellectual capacity, credibility, judgement,intuition.
- To adhere to punctuality, setting and meetingdeadlines.
- To instil responsibilities to oneself andothers.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchangeideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

At the end of the course the student will be able to:

- Present the project and be able to defendit.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the projecttask.
- Habituated to critical thinking and use problem solvingskills
- Communicate effectively and to present ideas clearly and coherently in both the written and oralforms.
- Work in a team to achieve commongoal.
- Learn on their own, reflect on their learning and take appropriate actions to improveit.