



**M S Ramaiah University of Applied Sciences**

**Program Structure and Course Details  
of  
M Tech (Transportation Engineering) Degree  
Programme**

**Programme Code: 078**

**Batch 2022-24**

**Department of Civil Engineering  
Faculty of Engineering and Technology  
M S Ramaiah University of Applied Sciences**

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Approved by the Academic Council in its 26th meeting held on 14th July 2022

Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Faculty	Engineering and Technology
Department	Civil Engineering
Name of the Programme	M.Tech in Transportation Engineering
Programme Code	078
Mode of Study	Full Time
Date of Commencement of the Programme	August 2022
Date of Programme Approval by the Academic Council of MSRUAS	20 <sup>th</sup> November 2018

### 1. Programme Objective

The aim of the programme is to produce postgraduates with advanced knowledge and understanding of Transportation Engineering; higher order critical, analytical, problem solving and transferable skills; ability to think rigorously and independently to meet higher level expectations of transportation industry, academics, research or take up entrepreneurial route.

### 2. Programme Outcomes (POs) / Graduate Attributes

- PO 1. Evaluate different modes of transportation based on travel demand forecasting and travel demand distribution models
- PO 2. Select appropriate materials and technology to design, construct, maintain and rehabilitate highways
- PO 3. Apply artificial intelligence and Intelligent Transportation System (ITS) to solve urban transportation issues
- PO 4. Use various software tools to model and simulate traffic flow to manage traffic issues
- PO 5. Analyze and design various types of bridges for road and railway projects
- PO 6. Develop and administer project budgets, fiscal control, contract and quality control provisions
- PO 7. Develop a career in transportation industry
- PO 8. Practice teamwork, lifelong learning and continuous improvement

### 3. Programme Specific Outcomes (PSOs)

The programme specific outcomes are listed under four headings:

- 1. Knowledge and Understanding
- 2. Cognitive skills
- 3. Practical skills and
- 4. Capability/Transferable skills

**Knowledge and Understanding:** After undergoing this programme, a student will be able to:

- KU1: Describe advantages and disadvantages of various pavement materials, construction methods and equipments used in pavement construction
- KU2: Describe the critical factors in design of pavement to achieve quality, durability, sustainability and economic objectives
- KU3: Explain principles of travel demand forecasting, modal split and traffic assignment, road safety used in transportation planning
- KU4: Explain form work, modern construction techniques, properties of modern construction materials and equipments applied to engineering construction for sub, super and special structures, rehabilitation, strengthening and demolition techniques

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**Cognitive Skills:** After undergoing this programme, a student will be able to:

- CS1:** Analyze and design various pavement systems, maintenance techniques to meet the overall expectation of the road project
- CS2:** Analyze and propose traffic study, simulation and remedial measure essential for solving a broad set of traffic problems in transportation industry considering societal and economic impacts
- CS3:** Plan surveys to collect and analyze data required for transportation planning
- CS4:** Propose and design various types of bridges for a road/railway project

**Practical Skills:** After undergoing this programme, a student will be able to:

- PS1:** Produce detailed project report along with the ability to carry out various studies essential for the preparation of DPR in different stages
- PS2:** Use appropriate software packages relevant to transportation engineering
- PS3:** Conduct physical tests to evaluate performance of pavement materials and mixes
- PS4:** Perform laboratory tests on model structures to understand their behavior

**Capability Skills / Transferrable Skills:** After undergoing the programme, a student will be able to:

- TS1:** Evaluate and appraise the context within which transportation industry operates
- TS2:** Adopt a reflective approach to personal development and embrace the philosophy of continual professional development
- TS3:** Present information concisely in narrative and verbal form
- TS4:** Work effectively in groups and lead the group

#### 4. Eligibility for Admission:

##### 4.1. Eligibility for students seeking admission under Government of Karnataka quota (for 40% seats):

- i. A candidate seeking admission to postgraduate programme must have passed graduate level in Engineering and Technology in a related discipline with at least 50% marks in aggregate or equivalent CGPA.
- ii. A candidate belonging to SC/ST category will be entitled to a relaxation in the qualifying marks in accordance with the related government notification in this regard.

##### 4.2. Eligibility for Indian students seeking admission under the university quota:

Students seeking admission under University quota must have passed graduate level degree in Engineering in a related discipline with at least 50% marks in aggregate or equivalent CGPA.

##### 4.3. Eligibility for foreign students seeking admission under University quota:

- i. Foreign students should have Association of Indian Universities recognized first degree qualification in the Engineering related discipline of equivalent
- ii. Should have proof of proficiency in English.

##### 4.4: Selection of Students

Selection of students for admission under Government of Karnataka will be based on Karnataka

Government notified admission tests.

Selection of students for admission to University quota of seats is based on admission policy of the University notified from time to time.

Selection of foreign students for admission to University quota of seats is based on the admission policy of the University notified from time to time.

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#### 4.4.1: Admission to Programme

Selected candidates shall complete the admission procedure within the prescribed date by paying the prescribed fees and completing all other admission formalities notified by the University. Failure to do so may lead to cancellation of the selection.

#### 4.4.2: Annual Programme Fee

Details of the fees payable for each Programme will be notified well in advance to the commencement of the programme.

The fees, once paid, will not be refunded under any circumstances.

The continuation of a student's registration in subsequent academic years is subject to payment of the prescribed programme and registration fees for each of those years.

#### 4.4.3: Free-ship and scholarships

The Board of Management, in consultation with the Board of Governors, may consider offering free ships / scholarships to deserving students who maintain a minimum level of academic performance on a yearly basis.

### 5. Programme Duration

**5.1. Normal Duration:** The normal duration of the M.Tech. Postgraduate programme is:

- a. Two years in the Full-Time Route
- b. Three years in the Part-Time Route

**5.2. Maximum Duration:** The maximum period a student is allowed to complete the M.Tech Programme shall be double the normal duration of the programme, i.e., Four Years for Full-Time students and Six years for Part-Time students.

**5.3. Duration for Lateral Entry Scheme:** N/A

### 6. Medium of Instruction

English is the medium of instruction for the programme.

### 7. Programme Structure

The programme structure is presented in **Appendix A**.

### 8. Programme Curriculum

The programme curriculum is presented in **Appendix B**.

### 9. Attendance Requirement

A student is required to have a minimum attendance of 80% to be eligible to appear for the examination and for assignment submission. Students who fail to achieve the minimum attendance will be declared as "FAIL". A failed student is required to re-register, attend the course and take up all the components of assessment at the next offering.

### 10. Assessment

**10.1. Achievement Testing:** During each semester, students' performance is assessed through two components, Continuous Evaluation (CE) and a Semester-End Examination (SEE). Both CE and SEE carry equal weight.

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**10.1.1. Continuous Evaluation (CE):** This includes term tests, assignments, viva-voce, quiz, seminars, mini projects and other such evaluation methods designed for specific courses and conducted as per the norms of the University for Assessment.

**10.1.2. Semester End Examination (SEE):** This includes a written/laboratory examination conducted as per the norms of the University for Assessment.

The attainment of student in all COs are evaluated. A typical evaluation template in a theory course is presented in Table 1. A student is required to score a minimum of 40% marks in each course, scoring a minimum of 40% in each of CE and SEE.

Course Outcome	CE (Weightage: 50 %)				SEE (Weightage: 50 %) Semester End Exam
	Component	Component	Component	Component	
	XX Marks	XX Marks	XX Marks	XX Marks	50 Marks
CO-1					
CO-2					
CO-3					
CO-4					
CO-5					
CO-6					

In the case of a laboratory course, there are two components: Component-1 and Component-2. Component-1 (CE) carries a weight of 50% and Component -2 (SEE) carries a weight of 50%.

The template for weightage of CE and SEE in percentages for each course is indicated in Table 2.

Course Outcome	Assessment Type	CE (Weightage: 50 %) 25 Marks				SEE (Weightage: 50 %): 25 Marks
		Conduction of Lab Exercises	Viva-Voce	Lab Record Submission	Lab Test	SEE
		Component Weightage	10 Marks	05 Marks	05 Marks	05 Marks
CO-1						
CO-2						
CO-3						
CO-4						
CO-5						
CO-6						

**10.1.2: Second Assessment and External Review**

Each student's work is first assessed by the Course teaching team. All the answer scripts of a given course are to be assessed by a second examiner. 10% of the evaluated scripts will be further reviewed by an examiner who is external to the University. An External examiner will have tenure of 2 years

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which can be renewed for a further period of 2 years. The first assessor or assessing team is required to fill in the evaluation data and write the Post Course Assessment Report (PMAR).

#### 10.1.2.2: Feedback on Assessed work

The awarded marks and distribution pattern will be reviewed by the Dean of the Faculty before scheduling a face-to-face feedback session with the student. After completing assessment of the course, the course teaching team along with the concerned Head of the Department should provide face-to-face feedback to the student regarding his/her performance after handing over the assessed documents on a prescheduled day. After the feedback, the assessed documents are collected and deposited with the Examination and Assessment Unit of the Faculty.

#### 10.3. Credits not earned in a Course and Opportunities for Make-up:

A minimum of 40 % marks in the assignment and a minimum of 40% marks in the written examination are required for successful completion of a course. A student failing in any one of the components will be declared 'FAILED' in the course. A failed student who has fulfilled the attendance criterion is eligible to re-sit under the fast track scheme.

There is no provision for a re-examination or re-submission of any of the assessment components for a failed course.

A maximum of 3 attempts, including the first attempt, are permitted for successful completion of a course.

### 11. Academic Awards

**Award of Grades:** Students will be awarded grades based on the marks scored. The basis for awarding grades is shown in Table 3.

Sl. No.	Marks Scored	Grading	GPA Grade Points
1.	91-100	O (Outstanding)	10
2.	75-90	A+ (Excellent)	9
3.	61-74	A (Very Good)	8
4.	55-60	B+ (Good)	7
5.	50-54	B (Above Average)	6
6.	45-49	C (Average)	5
7.	40-44	P (Pass)	4
8.	Below 40	F (Fail/Absent) RS – Re-sit RR – Re-registration	0

'RS' and 'RR' to be considered as 'F' for SGPA and CGPA calculations.

The SGPA is indicated in the transcript only if all credits prescribed for the semester are earned by the student.

#### Computation of CGPA:

$$CGPA = \frac{\sum_{i=1}^N \text{Grade points scored in a given course} \times \text{Number of credits for that course}}{\text{Total number of registered credits}}$$

Here,  $N$  is the total number of courses registered for in a semester.

Table 4: SGPA and CGPA calculations for two semesters					
SGPA and CGPA: Sem-1 (All courses excluding 'Consideration Courses')					
Course	Grade	Grade Point (GP)	Credit	GP * Credit	
C1	A	8	4	32	<b>SGPA</b> = 129/18 = 7.166 = 7.17
C2	B+	7	4	28	
C3	C	5	3	15	
C4	B	6	4	24	
C5	O	10	3	30	
Total			<b>18</b>	<b>129</b>	
Cumulative Credits and Grade Point * Credits			<b>18</b>	<b>129</b>	<b>CGPA</b> = 129/18 = 7.17
SGPA and CGPA: Sem-2 (All courses excluding 'Consideration Courses')					
Course	Grade	Grade Point (GP)	Credit	GP * Credit	
C10	O	10	3	30	<b>SGPA</b> = 97/14 = <b>6.93</b>
C11	A+	9	3	27	
C12	C	5	4	20	
C13	C	5	4	20	
Total			<b>14</b>	<b>97</b>	
Cumulative Credits and Grade Point * Credits			<b>18 + 14</b> = 32	<b>129 + 97</b> = 226	<b>CGPA</b> = 226/32 = 7.0625 = 7.10

Example: Typical SGPA and CGPA calculations for two semesters are shown in Table 4.

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**Appendix A**

**Programme Structure**

The Programme consists of four terms as shown below. A student is required to successfully complete the following courses and earn credits for the award of the degree.

Complete details of each of the courses such as ILO's, content, resources, teaching-learning processes and other related information are outlined in Course Specification of the respective programme.

**SEMESTER 1**

Sl.No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	19TRCS01A	Pavement Engineering	3	--	2	4	100
2	19TRCS02A	Traffic Engineering and Transport Planning	3	--	2	4	100
3	19TRCS03A	Construction Planning and Contract Management	3	1	2	5	100
4	19TRES1XA	Refer Elective Course Table	4	--	--	4	100
5	19TRES2XA	Refer Elective Course Table	4	--	--	4	100
6	19FETS08A	Research Methodology & IPR	2	--	--	2	50
7	19FETS09A	Professional Communication	1	--	--	--	--
Total			<b>20</b>	<b>2</b>	<b>4</b>	<b>23</b>	<b>450</b>
Total number of contact hours per week			<b>26 hours</b>				
Number of credits can be registered			Minimum	<b>15</b>	Maximum	<b>23</b>	

**SEMESTER 2**

Sl.No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	19TRCS11A	Intelligent Transport System	3	1	2	5	100
2	19TRCS12A	Railway Engineering	3	1	--	4	100
3	19TRCS13A	Airport Engineering	3	1	--	4	100
4	19TRES3XA	Refer Elective Course Table / Online Courses / MOOC	4	--	--	4	100
5	19TRES4XA	Refer Elective Course Table / Online Courses / MOOC	4	--	--	4	100
6	19FETS10A	Value Education	1	--	--	--	--
Total			<b>18</b>	<b>3</b>	<b>2</b>	<b>21</b>	<b>400</b>
Total number of contact hours per week			<b>26 hours</b>				
Number of credits can be registered			Minimum	<b>12</b>	Maximum	<b>21</b>	

**SEMESTER 3**

Sl.No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	19TRPS01A	Internship / Other activities as specified	--	--	10	4	100
2	19TRPS02A	Group Project	--	--	12	8	200
Total			--	--	<b>22</b>	<b>12</b>	<b>500</b>

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Total number of contact hours per week	22 hours			
Number of credits can be registered	Minimum	12	Maximum	12

SEMESTER 4

Sl.No.	Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	19TRPS22A	Dissertation and Publication	-	-	24	24	400
Total			-	-	24	24	400
Total number of contact hours per week			24 hours				
Number of credits can be registered			Minimum	24	Maximum	24	

Elective Courses List			
Stream / Specialization	S. No.	Course Code	Course Title
Group -1	E11	19TRES11A	Geometric Design of Highways and Expressways
	E12	19TRE 512A	Advanced Concrete technology and modern construction techniques
	E13	19TRE 513A	Transportation Geotechnics
	E14	19TRE 514A	Statistics for Transportation Engineers
Group -2	E21	19TRES21A	Direct Stiffness method and Finite element analysis
	E22	19TRES22A	Green construction and Alternative building materials
	E23	19TRES23A	Tunnel Engineering
	E24	19TRES24A	Advanced Structural Materials
Group -3	E25	19TRES25A	Design of Formwork and Precast Structures
	E31	19TRES31A	Bridge Engineering and Road Projects
	E32	19TRES32A	Harbours and Dock Engineering
	E33	19TRES33A	Smart Cities and Sustainable Infrastructure
Group -4	E34	19TRES34A	Environmental Impact Assessment for Civil Engineering Projects
	E41	19TRES41A	Application of AI in Transportation Engineering
	E42	19TRES42A	Pavement Construction, Evaluation, Maintenance and Management Systems
	E43	19TRES43A	Highway Economics, Finance and Road Safety Management
	E44	19TRES44A	Construction Equipment and Management

Note:

The Vacations and other activities shall be as per the Timetable for the corresponding batch.

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Course Title	Pavement Engineering
Course Code	19TRC501A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course deals with materials and their characteristics influencing the design and performance of different types of pavements. Students will be taught the analysis of stresses in flexible and rigid pavements and applications of various pavement design methods practiced in Indian and abroad. Students will also be taught about design and analysis of surface and subsurface drainage system applied to pavements.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Discuss the different types of materials used for pavement construction
- CO 2. Recommend the material for construction of different type of pavement for different site condition
- CO 3. Compare and contrast different pavement design methods for both flexible and rigid pavements
- CO 4. Design surface and subsurface drainage system for various pavements.
- CO 5. Design various types of flexible and rigid pavement and overlays for different site condition

### Course Contents

#### Unit 1 Pavement materials

Subgrade Soil: classification, desirable properties, determination of soil strength characteristics, resilient modulus

Road aggregates: classification, properties of aggregates, design of aggregate gradation

Bituminous binders: bitumen, emulsions, cut backs and modified binders, rheology of bituminous binders, modified binders: crumb rubber modified bitumen, natural rubber modified bitumen, polymer modified bitumen; basic and advanced tests on bituminous binders as per specifications, long term and

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short term ageing and its effect on bitumen performance, Tests to simulate ageing of bitumen viz. RTFOT and PAV, hot mix, warm mix and cold mix technologies

Mix design: Marshall method and Superpave mix design procedure, Visco-elastic and fatigue properties of bituminous mixtures, Requirements of paving concrete, joint filler and sealer material as per specifications

### Unit 2 Subgrade Soil stabilization

Importance of subgrade soil stabilization, discussion on techniques practiced for mechanical, chemical, nano material, natural and artificial fibres, geosynthetics and geofabric stabilization in pavements.

### Unit 3 Pavement Analysis and Design

Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements, functions of pavement components

Pavement Design Factors: Design wheel load, strength characteristics of pavement materials, climatic variations, traffic - load equivalence factors and equivalent wheel loads, aircraft loading, gear configuration and tyre pressure Flexible Pavement Design: Empirical, semi-empirical and theoretical approaches, design of highway and airport pavements, design of overlays and micro surfacing as per IRC specifications, AASHTO Methods, applications of pavement design software

### Unit 4 Rigid Pavement Design

Types of joints and their functions, joint spacing; design of CC Pavement for roads, highways and airports as per IRC, AASHTO, design of joints. Design of continuously reinforced concrete pavements, Types and characteristics of white topping, design of white topping as per IRC specifications. Reliability; Use of software for rigid pavement design, design of overlays.

### Unit 5 Pavement Drainage

Types of drainage, necessity, functions/ ideal requirements of good drainage system, design of surface drainage system, Hydraulics and hydrologic design, design of sub surface drainage system, design of filter material, drainage in marshy and water logged areas.

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### Course Resources

#### a. Essential Reading

1. Asphalt Institute., (1999) Thickness Design – Asphalt Pavements for Highways and Streets
2. Manual Series No. 1 (MS-1), Asphalt Institute, Kentucky, USA.
3. Croney D. and Croney P., (1991) The design and performance of road pavements, McGraw
4. Hill Book Company, London, UK.
5. Huang, Y.H., (2008) Pavement Analysis and Design, Second Edition, Dorling Kindersley (India) Pvt. Ltd., New Delhi, India.
6. Papagiannakis A.T. and Masad E.A., (2008) Pavement Design and Materials, John Wiley and Sons, New Jersey, USA.

#### b. Recommended Reading

1. Mallick, R.B. and T. El-Korchi., (2009) Pavement Engineering – Principles and Practice, CRC Press, Taylor and Francis Group, Florida, USA.
2. Ministry of Road Transport and Highways, (2013) Specifications for Road and Bridge Works, Fifth Edition, Indian Roads Congress, New Delhi, India.
3. Yang, N.C., (1972) Design of Functional Pavements, McGraw-Hill Book Company, New York, USA.
4. Yoder, E.J. and M.W. Witzak, (1975) Principles of Pavement Design, Second Edition, John Wiley and Sons, New York, USA.
5. IRC: 37 Guidelines for the Design of Flexible Pavements, the Indian Roads Congress, New Delhi, India.
6. IRC: 58 Guidelines for the Design of Plain Jointed Rigid Pavements for Highways, the Indian Roads Congress, New Delhi, India.

#### c. Magazines and Journals

1. International Journal of Pavement Engineering
2. The International Journal of Pavement Engineering & Asphalt Technology

#### d. Other Electronic Resources

1. <http://onlinepubs.trb.org/onlinepubs/archive/mepdg/home.htm>
2. <http://www.asphaltinstitute.org/thicknessdesignsw/> (30 days trial version)

  
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Course Title	Traffic Engineering and Transport planning
Course Code	19TRCS02A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course deals with various aspects of traffic engineering and traffic flow simulations in traffic engineering. Students will be taught traffic stream parameters, various macroscopic and microscopic models, traffic flow theory and air traffic management. Students will also be trained in various simulation techniques in traffic engineering.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Explain traffic stream parameters and traffic flow theory
- CO 2. Discuss the issues in transportation planning
- CO 3. Analyse planning process using four stage models
- CO 4. Formulate procedures for various traffic studies
- CO 5. Develop and apply simulation techniques in traffic engineering

### Course Contents

#### Unit 1 Introduction:

Components of road traffic – the vehicle, driver and the road, objectives and scope of traffic engineering.

#### Traffic Engineering Studies:

Sampling in traffic studies and its applications, objectives and methods of traffic study, Volume , speed and delay studies, O& D Studies, Parking studies, Design of parking facilities, Traffic signal design

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

#### Unit 2 Traffic flow theory:

Scope , definitions, Basic diagram of traffic flow, Lighthill and Witham's theory, Car following theory, Queuing theory and its applications to traffic engineering, Vehicle arrivals headways and gaps, Delay to traffic at uncontrolled intersections

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Simulation: Fundamental principle, application of simulation techniques in traffic engineering, formulation of simulation models.

**Unit 3 Transport Planning Process:**

Status of transportation in India. Objectives and scope of transport planning. Urban, regional and national transport planning. Transport planning process, various stages.

Urban transportation problem: Urban Issues, Travel Characteristics, Evolution of Planning Process, Supply and Demand – Systems approach

**Unit 4 Transportation planning for small and medium sized cities.**

Travel demand: Trends, Overall Planning process, Long term Vs Short term planning, Demand Function, Independent Variables, Travel Attributes, Assumptions in Demand Estimation, Sequential, and Simultaneous Approaches, Aggregate and Disaggregate Techniques.

**Unit 5 Four stage demand forecasting:**

UTPS Approach, Trip Generation Analysis: Trip purposes, Factors governing trip generation and attraction rates, multiple linear regression analysis, Category Analysis.

Trip Distribution: Need, Methods (constant factor method, average factor, frater, Furness, gravity & Tanners model, opportunity model)

**Unit 6 Traffic Assignment:** Basic Elements of Transport Networks, Coding, Route Properties, Path Building Criteria, Skimming Tree, All-or-Nothing Assignment, Multiple route assignment, Capacity Restraint Techniques, Diversion Curves.

Mode Split Analysis: General considerations, Factors affecting, recent developments in model split analysis.

**Course Resources**

**a. Essential Reading**

1. Class Notes
2. Kerner B. S., (2009) Introduction to Modern Traffic Flow Theory and Control, Springer, 1st Edition
3. Rajasekaran S. and Vijayalaksmi Pai G.A., (2005) Neural Network, Fuzzy Logic, and Genetic
4. Algorithms - Synthesis and Applications, Prentice Hall

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**b. Recommended Reading**

1. Drew D.R., (1978) Traffic Flow Theory and Control, McGraw Hill
2. Winston , P.H., (1999) Artificial Intelligence, Pearson Education
3. Lugur G. F., (2002) Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Addison - Wesley

**c. Magazines and Journals**

1. Journal of Traffic and Transportation Engineering
2. Modern Traffic and Transportation Engineering Research

**d. Other Electronic Resources**

1. <http://www.trafficresearch.co.uk/>
2. [https://www.sciencedaily.com/terms/traffic\\_engineering\\_\(transportation\).htm](https://www.sciencedaily.com/terms/traffic_engineering_(transportation).htm)

  
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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Construction Planning and Contract Management
Course Code	19TRE503A
Programme	Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course deals with various aspects of construction project management and their significance. Planning, scheduling and contractual procedures involved in a Civil Engineering project are also dealt. Students will be trained in the usage of computer software dealing with appropriate scheduling and tracking of various activities of a construction project. They will be made familiar with the contract procedures and laws to be followed in the various stages of a construction project.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Discuss the concepts of construction projects, project management functions, Legal and regulatory requirements, and administration of contract
- CO 2. Solve scheduling and tracking problems of a construction programme using suitable software
- CO 3. Analyze the procedures involved in undertaking technical, financial, economic and ecological feasibility studies for the preparation of construction project reports
- CO 4. Evaluate a construction project to develop the scope of work, plan various activities involved in a construction project, and optimize the construction projects using Big-M method
- CO 5. Optimize the construction projects using Simplex and transportation techniques
- CO 6. Prepare the tendering and contracting documents for infrastructure development projects covering technical, commercial and legal aspects

### Course Contents

**Unit 1 (Project Management):** Construction projects- concepts, project categories, characteristics of projects, project life cycle phases; Project management function-selection of professional services, construction contractors, role of a project manager; Legal and regulatory requirements; Changing environment of construction industry.

Objectives, types of project plans, resource planning process; Project feasibility reports- introduction, significance of feasibility report- technical analysis, financial analysis, economic analysis, ecological analysis, flow diagram for feasibility study of a project; Detailed project report; Different project clearances required; Analysis of risk, different methods, selection of a project and risk analysis in practice.

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**Unit 2 (Construction Planning):** Project formulation, capital investments, generation and screening of project ideas; Project identification, preliminary analysis, market, technical, financial, economic and ecological, prefeasibility report and its clearance; Basic concepts in the development of construction plans, choice of technology and construction method, organizational structure, project management tools, defining work tasks, defining precedence relationships among activities, estimating activity durations, estimating resource requirements for work activities, coding systems; Project control and review.

**Unit 3 (Optimization Techniques):** Linear, dynamic and integer programming- branch and bound techniques- application to production scheduling, equipment replacement, material transportation and work assignment problems, software applications.

Inventory Models: Deterministic and probabilistic inventory models- software applications

**Unit 4 (Scheduling Procedures and Techniques):** Construction schedules- Critical Path Method, PERT, scheduling calculations, float, presenting project schedules, scheduling for Activity-on-Arrow and with leads-lags and windows; Line of Balance and Linear Scheduling Method, resource oriented scheduling, scheduling with resource constraints and precedence, use of advanced scheduling techniques, scheduling with uncertain durations; Calculations for Monte Carlo schedule simulation; Crashing and time cost trade-offs; Improving the scheduling process.

**Unit 6 (Scheduling Applications, Design and Construction Processes):** Introduction to software like primavera, P6/ MS Project, for schedule development and tracking; Prolog, data management, RFI's (Request for Information), submittals, product data punch list.

Design and construction as an integrated system, innovation and technological feasibility, innovation and economic feasibility, design methodology, functional design, construction site environment

**Unit 7 (Construction Contracts and Tenders):** Definitions, essentials for a legally valid contract, salient features of a contract, discharging of a contract; Documents for an engineering contract, International Contract Document, Standard Contract Document; Classification based on tendering process, economic consideration, tasks involved; Main and subcontracts, features, merits, demerits, applicability of various types of contract; Indian Contracts Act, design of contract, laws of torts.

Definitions, list of documents, Earnest Money Deposit, Security Deposit, preparation of enquiry documents; Invitation of tenders and sale of document, preparation of tender documents and its submission, receipt of tender documents and its opening, evaluation of tender from technical, contractual and commercial points of view, contract formation and interpretation



Issues in tendering process: pre-registration, pre-qualification, nominated tendering, rejection of tenders, repeat orders, revocation of tenders, unbalanced bidding, cartel and collusion in tendering; Potential contractual problems, World Bank procedures and guidelines

**Unit 8 (Administration/ Performance of Contract):** Responsibilities (duties and liabilities) of principal and contractor, monitoring and quality control/ assurance; Settlement of claims, advances, bills, extension of time, extras and variations, cost escalations, retention money, performance bond, liquidated damages, penalties; Statutory requirements, social obligations/ responsibilities, labour welfare, reports, records, files.

**Breach of Contract, Dispute Resolution :** Definition and classification, common breaches by – principal, contractor, damage assessment, claims for damages, Quantum Meruit, Force Majeure or frustration.

General methods of dispute resolution- negotiation, mediation, conciliation, dispute resolution boards, arbitration, litigation/adjudication by courts; Conciliation- appointment of conciliator, role of conciliator, special features of conciliation; Dispute Resolution Boards(DRB)- constitution of DRB, functioning of DRB, procedure for hearings, status of award; Arbitration- comparison of actions and laws, agreements, course matter, violations, appointment of arbitrators, conditions of arbitrations, powers and duties of arbitrator, rules of evidence, enforcement of award, costs

Formulation of quadratic elements, rectangular elements and higher order elements, isoparametric formulation, stiffness matrices quadrilateral elements.

Legal requirements, International Contracts/ Contracts with International Funding : International competitive bidding, domestic preference, FIDIC document, conditions; Currency of bid and payment, escalation in foreign currency, financing of projects, applicable law and settlement of disputes, international arbitration; Private sector participation:- private sector participation in infrastructure development projects- Build, Operate and Transfer, Build, Operate, Lease and Transfer, Build, Own, Operate and Transfer; Technology transfer and foreign collaboration- scope of technology transfer.

### Course Resources

#### a. Essential Reading

1. Class Notes
2. Punmia B.C. and Khandelwal K.K., (2002) Project Planning and Control with PERT and CPM. Firewall Media.
3. Hinze J.,(2001) Construction Contracts, McGraw Hill.

#### b. Recommended Reading

1. Willis E. M., (1986) Scheduling Construction Projects, John Wiley & Sons.

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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

2. Feigenbaum L., (2002) Construction Scheduling with Primavera Project Planner Prentice Hall Inc.
3. Patil B.S., (2006) Civil Engineering Contracts and Estimates, Universities Press (India) Private Limited.
4. Prakash V. A., (1997) Contracts Management in Civil Engineering Projects, NICMAR.
5. John G. B., (1993) Engineering Contracts, McGraw Hills.
6. Vasavada B. J., (1997) Engineering Contracts and Arbitration, Self Publication by Jyoti Vasavada

**c. Magazines and Journals**

1. Engineering Construction and Architectural Management, Wiley
2. Project Management Journal, Project Management Institute

**d. Other Electronic Resources**

1. <http://nptel.ac.in/>

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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

<b>Course Title</b>	Geometric Design of Highways and Expressways
<b>Course Code</b>	19TRES11A
<b>Programme</b>	M.Tech in Transportation Engineering
<b>Department</b>	Civil Engineering
<b>Faculty</b>	Faculty of Engineering and Technology

### Course Summary

Geometric design is an integral part of transportation engineering. This course will provide detail insight on the highway geometric design, intersection and interchange design, integral for safety, mobility and efficiency of transportation system. It provides basic information on elements of highway geometry and sight distances along with other aspects of transportation system engineering and characteristics. This is an advance level course, which focuses on the existing research and application in the field of highway geometric design and train students to use the available guideline efficiently and effectively to design a sustainable highway. The course will also focus on effects of geometric design on traffic operations and overall it will be beneficial to students who want to pursue career in transportation engineering.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Discuss the significance and design of various geometrical elements.
- CO 2. Design Horizontal and vertical alignment as per relevant Indian standards.
- CO 3. Analyse and design various roadway intersections
- CO 4. Analyse and design various pedestrian and parking facilities.
- CO 5. Develop a design report using suitable highway design software.

### Course Contents

**Unit 1** Introduction: Geometric design provisions for various transportation facilities as per IRC guidelines, Factors governing geometric design, geometric design elements, route selection, geometric design consistency.

**Unit 2** Geometric Design Elements: Sight distances-Types, analysis, Factors affecting, measurements, horizontal alignment-Design consideration. Stability at curves, Super elevation, widening, transition curves, curvature at intersection, vertical alignment-Grades, ramps, design of summit and valley curves, Combination of vertical and horizontal alignment including design of hair pin bends

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**Unit 3** Cross Section Elements: Right of way and width consideration, roadway, shoulders, kerbs, traffic barriers, medians, frontage roads, Facilities for pedestrians, bicycles, buses and trucks ,pavement surface characteristics-Types, cross slope ,skid resistance, unevenness.

**Unit 4** Design Considerations: Design considerations for rural and urban roads - Design speeds, volumes, level of service and other design consideration.

**Unit 5** Intersection Design : At grade intersections – sight distance consideration and principles of design, Channelization, mini round – about, layout of round – about, Inter – Changes – major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, Bicycle and pedestrian facility design, Parking layout and design, Terminal layout and design.

**Unit 6** Requirements of Expressways: Geometric Design and General Features, Grade Separators and Interchanges, Embankment and Cut Sections, Pavement Design, Tunnels Drainage, Traffic Control Devices, Road Safety Devices and Road Side Furniture, Traffic Management Systems, Toll Plazas

**Unit 7** Project Facilities: Service Areas, Pick-Up Bus Stops, State Border Check Posts, Environmental and Social Aspects, Landscaping and Tree Plantation, Lighting.

Bicycle and pedestrian facility design, Parking layout and design, Terminal layout and design.

**Unit 8** Introduction to highway design software: Developing sight distance, profile for highway alignment, Evaluating existing horizontal and vertical curves, Super elevation development, Intersection design, Interchange design.

## Course Resources

### a. Essential Reading

1. Class Notes
2. Khanna S.K, Justo CEG, Veeraragavan A "Highway Engineering" Khanna Publishers, 10th Edition, 2015,ISBN: 9788185240800.

### a. Recommended Reading

1. John G Schoon "Geometric design projects for Highways: An Introduction" 2nd Edition, American Society of Civil Engineers Press, ISBN: 978-0-7844-7042-8, 2000. 4.
2. Donald R. Drew "Traffic Flow Theory and Control" McGraw-Hill Inc.,US (1 June 1968), ISBN-10: 0070178313. 5.
3. Relevant Indian Roads Congress Code Books(IRC) IRC011-1962,IRC012-2009,IRC032-1969,IRC064-1990,IRC066-1976,IRC0731990,IRC080-1981,IRC086-1983,ITC092-1985,IRCSP023-1993 ,IRCSP99

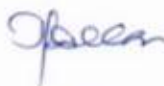
Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

2013.Publisher Indian Roads Congress, New Delhi.

**b. Other Electronic Resources**

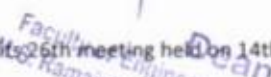
3. Electronic resources on the subject area are available at MSRUEAS library

  
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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Advanced Concrete Technology and Modern Construction Techniques
Course Code	19TRES12A
Programme	Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course deals with concrete, its components, properties and applications. Students will be taught concepts and procedures of concrete mix design. Concreting technologies, special concretes and their applications. Students will be trained to conduct tests on fresh and hardened concrete and evaluate their properties.

This course deals with various construction equipment and technologies adopted in the construction of different components of Civil Engineering structures. Identification, selection, planning and application of construction equipment and scaffolding technology will be discussed. The various techniques and technologies and their applications in the construction of substructures, superstructures and special structures as well as in the rehabilitation, strengthening, demolition and dismantling of Civil Engineering structures will be discussed.

### Course Outcomes

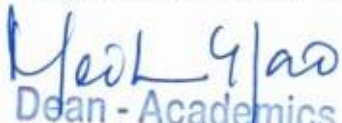
After undergoing this course students will be able to:

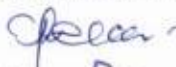
- CO 1. Discuss the properties of fresh and hardened concrete along with the relevant test details
- CO 2. Compare and contrast the different technologies involved in manufacture, mix design and placement methods of concrete
- CO 3. Apply different codal provisions and prepare mix design of concrete and recommend suitable type of concrete for a given set of conditions
- CO 4. Discuss and compare different equipment and construction techniques adopted in the construction of substructures, superstructures and special structures
- CO 5. Discuss the retrofitting, dismantling and demolition procedures adopted for existing structures

### Course Contents

**Unit 1 (Mix Proportioning of Concrete):** Principles and methods. Mix Design: Principles of concrete mix design, factors affecting mix design; Methods of concrete mix design- IS method, ACI method, DOE method, Statistical quality control, sampling and acceptance criteria.

Concreting Methods: Process of manufacturing of concrete, methods of transportation, placing, curing; Extreme weather concreting; Special concreting methods; Vacuum dewatering; Underwater concreting

  
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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Properties of Concrete: Durability of concrete- introduction, permeability of concrete, chemical attack, acid attack, efflorescence, corrosion in concrete, thermal conductivity, thermal diffusivity, specific heat, alkali-aggregate reaction, IS 456-2000 requirement of durability; Elastic properties.

Creep and shrinkage; Tests on fresh concrete; Tests on hardened concrete- effect of end condition of specimen, capping, H/D ratio, rate of loading, moisture condition, compression, tension and flexure tests, tests on composition of hardened concrete, cement content, original water, cement ratio, NDT tests concepts, rebound hammer and pulse velocity methods.

Special Concretes: Light weight concrete- Introduction, classification, properties, strength and durability, mix proportioning and problems;

High density concrete- radiation shielding ability of concrete materials for high density concrete, mix proportioning, properties in fresh and hardened state, placement methods.

**Unit 2 (Ferro cement):** Ferro cement materials, mechanical properties, cracking of Ferro cement, strength and behavior in tension, compression and flexure, design of Ferro cement in tension, Ferro cement constructions, durability and applications;

Fiber reinforced concrete- fiber materials, mix proportioning, distribution and orientation, interfacial bond, properties in fresh state, strength and behavior in compression and tension including pre-cracking and post cracking stages, behavior in flexure and shear; Fiber reinforced concrete- mechanical properties, crack arrest and toughening mechanism, applications; High performance concrete- constituents, mix proportioning, properties in fresh and hardened states, applications and limitations;

RMC concrete- manufacture, transporting, placing, precautions; Methods of concreting pumping, underwater concrete, shotcrete; High volume fly ash concrete- concept, properties, typical mix;

Self compacting concrete- concept, materials, tests, properties, applications and typical mix; Reactive powder concrete; Bacterial concrete; Fly ash concrete; Sulphur impregnated concrete; Polymer concrete; Geopolymer concrete; Waste material based concrete.

**Unit 3 (Construction Equipment and Management):** Identification, selection and planning of equipment, equipment management and maintenance, equipment operating cost and cost control of equipment

**Unit 4 (Earthwork Equipment):** fundamentals of earthwork operations, earthmoving operations; Types of earthwork equipment- tractors- motor graders- scrapers- front end loaders- dozers- excavators- rippers- loaders- trucks and hauling equipment, compacting equipment, finishing equipment; Equipment for excavating, dredging and trenching, dragline and clamshells; Tunneling- drilling, blasting equipments; Foundation and pile driving equipment; Erection equipments- cranes; Types of pumps used in construction, equipment for dewatering and grouting

Materials handling equipment-forklifts and related equipment, portable material bins, material handling conveyors, material handling cranes, industrial trucks; Concrete plants- aggregate production, different crushers, feeders, screening equipment, handling equipment, batching and mixing equipment, pumping

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equipment, ready-mix concrete equipment- concrete pouring equipment; Asphalt plant, asphalt pavers, asphalt compacting equipment; Precast flat panel system, 3D volumetric construction; precast foundations; fabrication of pre-cast and prestressed components; reinforcing steel- bending, placing, splicing and spacing, tendons.

**Unit 5 (Substructure Construction):** Box jacking, pipe jacking; Under water construction of basement; Tunneling techniques; piling techniques; Driving well and caisson; Sinking cofferdam; Cable anchoring and grouting; Driving diaphragm walls, sheet piles; Laying operations for built-up offshore system, shoring for deep cutting; Large reservoir construction with membranes and earth system, well points; Dewatering and stand by plant equipment for underground open excavation.

**Unit 6 (Superstructure Construction):** Vacuums dewatering of concrete flooring; Concrete paving technology; Techniques of construction of continuous concreting operation in tall buildings of various shapes and varying sections; Launching techniques; Suspended formwork; Erection technique of tall structures; Large span structures; In-situ prestressing in high rise structures; Post- tensioning of slab; Aerial transporting, handling, erecting light weight components on tall structures.

**Unit 7 (Construction of Special Structures):** Erection of lattice towers and rigging of transmission line structures; Construction sequence in cooling towers, silos, chimney, sky scrapers; Construction of bow string bridges, cable stayed bridges; Launching and pushing of box decks; Construction of jetties and breakwater structures; Construction sequence and methods in domes; Support structures for heavy equipment and machinery in heavy industries; Erection of articulated structures and space decks.

**Unit 8 (Rehabilitation and Strengthening Techniques; Demolition and Dismantling):** Seismic retrofitting; Strengthening of columns, strengthening of slab, strengthening of masonry wall; Protection methods of structures; Mud jacking and grouting for foundation, micro piling and underpinning for strengthening floor and shallow profile; Sub grade waterproofing; Soil stabilization techniques.

Demolition techniques- demolition by machines, demolition by explosives, advanced techniques using robotic machines, demolition sequence; Dismantling techniques; Safety precautions in demolition and dismantling.

#### Course Resources

##### a. Essential Reading

1. Class Notes
2. Shetty M. S.,(2009) Concrete Technology, S. Chand and Co. Ltd
3. Ashby M.F. and Jones D.R.H.H.,(2005) Engineering Materials 1: An introduction to Properties, applications and designs, Elsevier Publications
4. Deodhar S.V.,(2010) Construction Equipment and Job Planning, Khanna Publishers, New Delhi
5. Peter H.E.,(2008) Concrete repair and maintenance illustrated, Galgotia Publications Pvt. Ltd



**b. Recommended Reading**

1. Aitkens(1999) High Performance Concrete, McGraw Hill
2. Mamlouk M.S. and Zaniewski J.P.,(1999) Materials for Civil and Construction Engineers, Prentice Hall Inc.
3. Peurifoy R.L., Ledbetter W.B. and Schexnayder C.,(2006) Construction Planning, Equipment and Methods, McGraw Hill, Singapore
4. Ataev S. S., (1985) Construction Technology, Mir Publishers, Moscow
5. Allen R. T. and Edwards S. C.,(1993) Repair of Concrete Structures, Blakie and Sons, UK
6. Santhakumar A.R.,(1992) Training Programme notes on Damage Assessment and rLeopwair Co inst Housing, RHDC-NBO Anna University

**c. Magazines and Journals**

1. ACI Materials Journal, American Concrete Institute
2. Engineering Construction and Architectural Management, Wiley

**d. Other Electronic Resources**

1. <http://nptel.ac.in/>

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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Transportation Geotechnics
Course Code	19TRE513A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course deals with the properties and behaviour as a highway material under the application of wheel loads, understand and compare the shear strength of soil and stability of slopes when used as subgrade soil and embankment fills or cut slopes, understand the permeability characteristics of soils to design proper drainage system and various investigations required to assess the soil properties. Understand the type and soil composition affecting the surface runoff and sub-surface water flow in order to design proper drainage system, Analyse lack of strength or instability problems in soils due to soil formation or any other reasons and propose suitable strengthening methods for the same.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Analyse the wheel load effects on pavement materials
- CO 2. Evaluate and compare the shear strength of soil and stability of slopes when used as pavement component
- CO 3. Design proper drainage system by knowing the permeability characteristics of soils
- CO 4. Design surface runoff and sub-surface drainage system as per field conditions
- CO 5. Propose suitable strengthening methods for soil from the knowledge of lack of strength or instability in soils

### Course Contents

#### Unit 1

**Introduction:** Soil Mechanics applications to Highway Engineering. Soil formations, Types, Regional Soil deposits of India, Index properties, their determination, importance, various soil classification systems, HRB classification, problems on these.

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

#### Unit 2

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

**Stability of slopes:** Introduction, Types, Different methods of analysis of slopes for  $\phi$ - $c$  &  $c$ - $\phi$  soil, Location of most critical circle, Earth dam slopes stability, Taylor's stability number. Effect of Earthquake Force, problems on above.

### Unit 3

**Permeability of soil:** Darcy's Law, Validity, Soil-water system, Types, Determination of permeability, problems.

**Site Investigation:** Introduction, Planning exploration programmes, Methods, Samplers, SPT, Subsoil investigation Report, Geophysical methods.

### Unit 4

**Highway Drainage:** Introduction, Importance, Surface drainage, Subsurface drainage, methods, Design of subsurface drainage system, Road construction in water logged areas, Landslides – definition, classifies, factors producing.

### Unit 5

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

## Course Resources

### a. Essential Reading

1. "Basic and Applied soil Mechanics", Gopal Ranjan, ASR Rao, New Age International Publishers
2. "Soil Mechanics & Foundation Engg", Dr.B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Laxmi Publications (P) Ltd, 16th edition.
3. "Highway Engg", S.K. Khanna, C.E.G. Justo, 5th edition.

### b. Recommended Reading

1. "Soil Mechanics & Foundation Engg" – K.R. Arora Standard Publishers Distributors
2. "Soil Mechanics for road Engineers" – HMSO, London. 6. IRC – Relevant Codes.

### c. Magazines and Journals

1. International Journal of Geotechnical Engineering

### d. Other Electronic Resources

1. <http://onlinepubs.trb.org/onlinepubs/archive/mepdg/home.htm>

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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Applied Statistics for Transportation Engineers
Course Code	19TRE514A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course deals with Understand the use of statistical tools to express the traffic data for better interpretation. Apply probability concept to understand the vehicular flow behaviour helping the planners to predict traffic flow. Use appropriate statistical testing tools to check the degree of accuracy in the traffic data analysis. Test the hypothesis and assess the error involved in the data analysis. Use software tools like MATLAB, MINITAB etc., for analysis of traffic data and also use curve fitting techniques for predicting the performance trends.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Use statistical tools to express the traffic data for better interpretation.
- CO 2. Apply probability concept to understand the vehicular flow behaviour helping the planners to predict traffic flow.
- CO 3. Use appropriate statistical testing tools to check the degree of accuracy in the traffic data analysis.
- CO 4. Test the hypothesis and assess the error involved in the data analysis.
- CO 5. Use software tools like MATLAB, MINITAB etc., for analysis of traffic data and also use curve fitting techniques for predicting the performance trends.

### Course Contents

#### Unit 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 of central tendency – arithmetic mean, median and mode dispersion- range, standard deviation, variance and co-efficient of variation, skewness and kurtosis.

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## Unit 2

**Introduction to probability & statistics for Traffic Engineering Design** –Introduction, Random variables and statistical measures: arithmetic mean, measures of dispersion, basic laws of probability, probability laws for discrete random variables: binomial and Poisson distribution, probability laws for continuous random variables: normal distribution, Poisson distribution.

## Unit 3

Sampling Techniques – objective, basics of sampling, advantages of sampling, sampling techniques, sampling distributions – sampling distribution of the sample mean, central limit theorem, chi square, t and F – distributions. Sampling error, sample size and design.

## Unit 4

Statistical decisions – point estimation, properties of parameters, Testing of Hypothesis – Type I and II errors. Tests of significance – tests for mean and variance. Tests for proportions.

## Unit 5

Chi-square test of goodness of fit, student's t test, Confidence interval. Curve fitting by the method of least squares, Linear correlation & regression, multiple linear regression. Analysis of variance Use of softwares in statistical analysis – MATLAB, MINITAB

### Course Resources

#### a. Essential Reading

4. Martin Wohl, Brian V Martin, "Traffic System Analysis"- Mc Graw Hill Series
5. Johnson R and G Bhattacharya, "Statistics – Principles and methods"- John Wiley & sons, New York, 1985
6. Medhi, "Introduction to statistics"- New Age Pub, New Delhi
7. Benjamin Jack R and Cornell C Allin, "Probability Statistics & Decisions for Civil Engineers"- McGraw Hill Co.

#### b. Recommended Reading

3. Agarwal, B.L, "Basic Statistics"- 3rd edition, New Age Pub. New Delhi.
4. L.R Kadiyali, "Traffic Engineering"- Khanna Publishers New Delhi

#### c. Magazines and Journals

2. International Journal of Traffic Engineering

#### d. Other Electronic Resources

2. <http://onlinepubs.trb.org/onlinepubs/archive/mepdg/home.htm>

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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

<b>Course Title</b>	Direct Stiffness Method and Finite Element Analysis
<b>Course Code</b>	19TRES21A
<b>Programme</b>	M.Tech in Transportation Engineering
<b>Department</b>	Civil Engineering
<b>Faculty</b>	Faculty of Engineering and Technology

### Course Summary

This course is intended to prepare students to solve structural problems using finite element methods. Basic procedure, meshing, Interpolation models, shape function and theory of iso-parametric elements will be discussed. Application and formulation of finite element methodology to solve one dimensional, two dimensional, three dimensional elements and Jacobian matrix will be taught. Students will be trained to use FEM packages to solve complex problems and to develop computer algorithms, flow charts, simple computer program for the analysis of 2D structures. This course also deals with the finite element formulation of axisymmetric element and its applications.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1.** Describe basic concepts, background review, theory of elasticity, energy concepts, equilibrium, energy methods for analysing structures concepts of discretization and element formulation for finite element analysis
- CO 2.** Recognize the scope for finite element analysis in civil structural design
- CO 3.** Develop Interpolation models and shape functions in generalized and natural coordinates for 1D, 2D, 3D elements and axisymmetric elements
- CO 4.** Model and analyse manually 1D and 2D structures
- CO 5.** Compare and contrast analyses structures by using different elements

### Course Contents

#### Unit 1 Introduction FEA:

Basic concepts, background review, theory of elasticity, energy concepts, equilibrium and energy methods for analysing structures.

**Unit 2** Matrix displacement formulation, introduction to direct stiffness method, local and global co-ordinate system, transformation of variables, transformation of the member displacement matrix, transformation of the member force matrix, transformation of the member stiffness matrix, transformation of the stiffness matrix of the member of a truss, transformation of the stiffness matrix of the member of the rigid frame, overall stiffness matrix, boundary conditions, computation of internal forces. Analysis of trusses and continuous beams by direct stiffness method.

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**Unit 3** Approximate method of structural analysis, Raleigh - Ritz Method, Galerkin's method application in structural analysis, finite difference method and finite element method. Principles of finite element method, finite element procedure, engineering applications of finite element method, advantages and disadvantages.

Euler's Lagrange's equations of bar, beams, principal of a minimum potential energy, principle of virtual work, principle of Varians, variation method and minimization of energy approach of element formulation.

**Unit 4 Basic Procedure:**

Discretization process, types of elements 1D, 2D and 3D elements, simplex, complex and multiplex elements, size of the elements, location of nodes, node numbering scheme, half bandwidth, properties of stiffness matrix, pre-processing, post processing.

Finite elements used for one, two & three dimensional problems, element aspect ratio, mesh refinement vs. higher order elements, numbering of nodes to minimize band width.

Meshing:

Higher order elements, p and h methods of mesh refinement, ill conditioned elements, discretization errors, auto and adaptive mesh generation techniques, error evaluation.

Interpolation models:

Selection of the order of the interpolation polynomial, convergence requirements, 2d Pascal triangle, nodal displacement parameters, convergence criterion, compatibility requirements, geometric invariance.

Shape function:

Polynomial form of interpolation functions- linear, quadratic and cubic, linear interpolation polynomials in terms of global coordinates of bar, triangular (2D simplex) elements.

Linear interpolation polynomials in terms of local coordinates of bar, triangular (2D simplex) elements, CST element. Lagrange's shape functions in generalized and natural coordinates, serendipity family of elements, and Hermitian polynomials.

**Unit 5 Theory of isoperimetric elements:**

Isoperimetric, sub-parametric and super- parametric elements, characteristics of isoperimetric elements, validity of isoperimetric elements, numerical integration, Jacobian transformation matrix.

**Unit 6 1- D element formulation and its applications:**

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Mathematical modelling of 1-D element for characteristics evaluation, extraction of shape functions in natural and global co-ordinates for higher order bar elements.

Derivation of element stiffness matrices and load vectors, under axial loading, concentrated and distributed loads for bar element.

Solution of bars, stepped bars, plane trusses for displacements, reactions and stresses by using elimination approach, penalty approach. Derivation of element stiffness matrices and load vectors for concentrated and distributed loads for beam element.

Application of FEM to analysis of continuous beams and frames, stiffness of truss members, analysis of truss, and stiffness of beam members, grid members, and finite element analysis of continuous beam, plane frame, grid and space frame.

#### Unit 7 2-D element formulation and applications:

Plane -stress and plane-strain problems, formulation of triangular element and its higher orders, constant strain triangle, linear strain triangle, isoparametric formulation for triangular elements, stiffness matrices.

Formulation of quadratic elements, rectangular elements and higher order elements, isoparametric formulation, stiffness matrices quadrilateral elements.

Computation of Jacobian matrix, consistent load vector, stresses and strains for 2D elements. Need for mesh quality checks and their effect on analysis, computer algorithms, flow charts, simple computer program for the analysis of 2D structures.

#### Unit 8 3-D element formulation and applications:

Finite element formulation, hexahedral elements and higher order elements, element stiffness, force terms, stress calculations, problems on modeling.

Axisymmetric cases:

Finite element formulation of axisymmetric element, derivation of the stiffness matrix, stress calculations, finite element formulation for 3 dimensional elements, applications of axisymmetric elements.

#### Course Resources

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**a. Essential Reading**

1. Class Notes
2. C.S. Krishnamoorthy,(2011) Finite Element Analysis, Tata McGraw-Hill
3. David V. Hutton,(2003) Fundamentals of Finite Element Analysis, McGraw-Hill
4. Daryl L. Logan,(2014) A First Programme In the Finite Element Method, University of Wisconsin-Platteville
5. S S Bhavikatti,(2010) Finite Element Analysis, New age international Pvt. Ltd.

**b. Recommended Reading**

1. D. Maity,(2007) Computer Analysis of Framed Structures, I. K. International Pvt. Ltd.
2. New Delhi
3. Erik G. TDhompson, (2004) Introduction to the Finite Element Method: Theory, Programming and Applications, John Wiley
4. H. C. Martin and G. F. Carey,(1979) Introduction to Finite Element Analysis - Theory and Application, NewYork, McGraw-Hill
5. Irving H. Shames, Clive L. Dym,(1995) Energy and Finite Element Methods in Structural Mechanics; New Age International
6. K. J. Bathe,(2007) Finite Element Procedures, Prentice-Hall of India, New Delhi, India

**c. Magazines and Journals**

1. Journal of Structural Engineering, CSIR-Structural Engineering Research Centre, CSIR Campus, Chennai
2. ACI Structural Journal, ACI Structural Journal American Concrete Institute, 38800 Country Club Dr. Farmington Hills, MI48331-34349 USA

**d. Other Electronic Resources**

1. <http://www.sciencedirect.com>
2. Electronic resources on the course area are available at MSRUAS library

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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Green construction and Alternative building materials
Course Code	19TRE522A
Programme	Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course emphasizes on green building delivery and life cycle which includes need analysis, building planning, design review and post-occupancy evaluation. The students are taught building design which involve ecology, architecture, community health and building environment aspects. Sustainability in building resources like alternate and green building materials and processes are also dealt.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Discuss the green concepts, components of sustainable design and construction, modern, green and alternate building materials.
- CO 2. Discuss building economics and cost effective design for green construction
- CO 3. Apply sustainable techniques in planning and execution of construction projects
- CO 4. Compare and contrast different equipments and construction techniques adopted in the construction of substructures, superstructures and special structures
- CO 5. Compare and choose different alternate building materials and technologies suitable for a particular construction project
- CO 6. Design green building and construction process

### Course Contents

**Unit1 Introduction:** Energy in building materials, Impact of Energy and Atmosphere, Environmental issues concerned to building materials, Global warming and construction industry, Environmental friendly and cost effective building technologies, Requirements for building of different climatic regions, Traditional building methods and vernacular architecture.

**Unit 2 Introduction to Green Construction:** Green Concepts and Vocabulary, Components of Sustainable Design and Construction, Green Design and the Construction Process, Building Information Modeling, Indoor Environment Quality, Water Efficiency and Sanitary Waste, Indian Green Building Council (IGBC) certification.

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**Unit 3 Green Design, analysis and documentation:** Green Design and Building Economics, Green Project Cost Monitoring and Closeout, Green Project Commissioning, Project Cost Analysis, Green Specifications and Documentation, Types of Building Contract Agreements, Green Business Development, Building Green Litigation and Liability Issues

**Unit 4 Modern Construction Materials:** Types of steel and their properties, advantages of new alloy steels- properties and advantages of aluminum and its products, types of coatings and coatings to reinforcement, application of coatings; Types of plastics, non-weathering materials and their uses; Types of flooring and façade materials and their applications; Construction chemicals - Types and properties of water proofing compounds, sealants, engineering grouts, mortars, admixtures and adhesives; Smart materials- types and differences between smart and intelligent materials, special features, case studies showing the applications of smart and intelligent materials.

**Unit 5 Green and Alternative Building Materials:** Green Building Materials and Products, Characteristics of building blocks for walls, Stones and Laterite blocks, Bricks and hollow clay blocks, Concrete blocks, Stabilized blocks: Mud Blocks, Steam Cured Blocks, Fal-G Blocks and Stone Masonry Block. Lime-Pozzolana Cements: Raw materials, Properties and uses, manufacturing process

Fibre reinforced plastics, Matrix materials, Fibers : organic and synthetic with its properties and applications, Building materials from agro and industrial wastes, Types of agro wastes, Types of industrial and mine wastes with its properties and applications, Field quality control test methods.

**Unit 6. Equipment for Production of Alternative Materials:** Equipment for production of stabilized blocks, Moulds required, and methods of production of precast elements.

**Unit 7. Alternative Building Technologies:** Alternative for wall construction – types, construction methods, Masonry mortars – types, preparation and properties, Alternative roofing systems – concepts, filler slab, Composite beam panel roofs, Masonry walls and domes.

**Unit 8. Cost Effective Building Design:** Cost concepts in buildings, Cost saving techniques in planning, design and construction, Cost Analysis: Case studies using alternative materials and processes.

#### Course Resources

##### a. Essential Reading

1. Class Notes
2. Kubba S., (2012) Handbook of Green Building Design, and Construction, Butterworth-Heinemann
3. Sabnis G. M., (2012) Green Building with Concrete: Sustainable Design and Construction, CRC Press Deodhar S.V.,(2010) Construction Equipment and Job Planning, Khanna Publishers, New Delhi

##### b. Recommended Reading

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1. Cheshire D., (2016) Building Revolutions: Applying the Circular Economy to the Built Environment, RIBA Publishing
2. Hall K., (2008) The Green Building Bible Volume 1 & 2, Green Building Press
3. Johnston D., Gibson S., (2008) Green from the ground up: a builder's guide : sustainable, healthy, and energy-efficient home construction, Taunton Press

**c. Magazines and Journals**

1. ACI Materials Journal, American Concrete Institute
2. Engineering Construction and Architectural Management, Wiley

**d. Other Electronic Resources**

1. <http://nptel.ac.in/>

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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

<b>Course Title</b>	Tunnel Engineering
<b>Course Code</b>	19TRES23A
<b>Programme</b>	M.Tech in Transportation Engineering
<b>Department</b>	Civil Engineering
<b>Faculty</b>	Faculty of Engineering and Technology

### Course Summary

Obstacles along an alignment of a transportation mode has always been a challenge for a transportation engineer. This course emphasizes on the general aspects of transportation tunnels, Planning, Design, Construction and Maintenance of transportation tunnels.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1.** Discuss the general aspects of tunnel components
- CO 2.** Discuss the methods and stages in tunnelling
- CO 3.** Design and construct the tunnel components
- CO 4.** Discuss about the safety norms and maintenance measures in transportation tunnelling

### Course Contents

#### Unit 1 General Aspects of Tunnel Engineering:

General, Categories of obstacles, definitions, Advantages and Disadvantages of tunnels and open cuts, History of constructed tunnels, Developments in tunnelling methods, Economics of tunnelling, Classification of tunnels, Tunnel approaches, Metro tunnels.

#### Unit 2 Stages in tunnel construction:

Investigations, Setting out of tunnel, Excavation, Blasting, Temporary and permanent supports, Ventilation during construction, Mock removal, Supplementary operations, Design of shape and size.

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**Unit 3 Soil Classification and Tunnelling Methods:**

Soil classification, Choice of method, Methods of tunnelling in soft soils-Fore poling, Needle beam, Army, American, English, Belgian, German, Austrian, Timbering in soft soil tunnelling, Other popular methods of tunnelling in soft soil.

**Unit 4 Tunnelling in Water Bearing Soils:**

General, Well points system, Plenum process or compressed air method, Pipes and conduits, Tunnelling equipments, Methods.

**Unit 5 Tunnelling in Rocks:**

General, Sequence and faces of operations, Methods, Mucking, Hauling, General aspects, Drill bits, Nipper cars, Explosives, Safety precautions.

**Unit 6 Shafts:**

General, Advantages, Sizes and location, Construction in soft and hard starts, Supports, Protection, Classification.

**Unit 7 Tunnel Lining, Drainage and Maintenance:**

Tunnel Lining:

Necessity, Objectives, Materials, Thickness design, Sequence of lining.

Tunnel Drainage:

General, Pre-drainage, Dewatering, Permanent drainage

Inspection and maintenance of tunnels

**Unit 8 Tunnel Ventilation, Lighting and Health Protection:**

General, Temporary and Permanent ventilation, Dust prevention, Lighting, Safety measures, Health protection

  
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**Course Resources**

**a. Essential Reading**

3. Class Notes
4. Harbour Dock and Tunnel Engineering, R. Srinivasan, Charotar Publications
5. Transportation Tunnels, S. Ponnuswamy and D Johnson Victor, Oxford and IBH Publications

**a. Recommended Reading**

1. "The Art of Tunnelling" by K Szechy
2. "TUNNEL ENGINEERING HANDBOOK" by John O Bickel
3. "Handbook Of Tunnel Engineering II: Basics And Additional Services For Design And Construction" by Ulrich Maidl
4. "Roads Railways Bridges Tunnels Engineering" by T D Ahuja
5. "Handbook Of Tunnel Fire Safety" by Alan Beard

**b. Other Electronic Resources**

3. Electronic resources on the subject area are available at MSRUEAS library
4. Journal Of Tunnel Engineering, JSCE

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Faculty of Engineering and Technology  
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Course Title	Advanced Structural Materials
Course Code	19TRE524A
Programme	Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course explores the materials science of structural materials, and attempts to bring about the understanding of material behaviour from a fundamental perspective. The behaviour of various types of advanced materials used in the construction engineering is discussed. The course also focusses on fibre reinforced plastics, smart materials and durability and deterioration of concrete structures.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Discuss the different types of advanced structural materials used in building construction
- CO 2. Discuss the application of fibre reinforced plastics and smart materials in engineering structures
- CO 3. Develop and design high strength, high density and high performance concrete mix
- CO 4. Discuss the microstructure of cementitious materials and durability and deterioration of concrete structures
- CO 5. Compare and choose different structural materials and technologies suitable for a particular construction project
- CO 6. Recommend technologies for production of advanced structural materials for engineering construction

### Course Contents

#### Unit 1:

Introduction: types of concrete and cementitious materials, Types of steel and their properties, advantages of new alloy steels, Types of plastics, non-weathering materials

#### Unit 2 :

Special Concretes: Definition & Introduction, General properties, Advantages, Disadvantages, Applications, High density concrete, Shrinkage compensating concrete, Mass concrete, Roller compacted concrete. Light weight concrete, High strength concrete, Ultra-high strength concrete (reactive powder concrete). High performance concrete.

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**Unit 3:**

Fibre Reinforced Plastics in construction (FRP): Introduction, types, uses, properties, manufacturing, advantages and disadvantages. Types of fibres and components of composite materials

**Unit 4 :**

Smart Construction Materials: Introduction, types of smart materials- shape memory alloys, magnetostrictive materials, piezoelectric materials, electrorheological fluids, Electrochromic materials, smart concrete and application of smart materials

**Unit 5:**

Microstructure of cement based materials – Identification and detection of hydrated compounds using specialized techniques including FTIR, TGA, XRD, XRF, NMR, SEM, Optical microscopy, Calorimetry and several others. Relationship between microstructural parameters such as porosity, permeability, pore structure of concrete with associated properties

**Unit 6 :**

Durability and deterioration of concrete structures: Definitions, Deterioration processes – Physical, Chemical, Environmental & Biological; Measures for ensuring durability, Corrosion of reinforcing steel, protective measures.

**Course Resources**

**a. Essential Reading**

1. Class Notes
2. Sabnis S.P. Arora & S.P. Bindra, A Text Book of Building Construction, Dhanpat Rai & Sons, New Delhi., 2010
3. Sheety, M.S, Concrete Technology, Theory and Practice, S. Chand and Company Ltd, New Delhi, 2008

**b. Recommended Reading**

1. Gambhir, M.L, Concrete Technology, Tata McGraw – Hill Publishing Company Ltd, New Delhi, 2013
2. Pijush Samui, Dookie Kim, New Materials in Civil Engineering, Butterworth-Heinemann, Elsevier, 2020
3. Lawrence C. Bank, Composite for Construction: Structural Design with FRP Materials, John Wiley & Sons, INC., New Jersey.
4. Concrete: Microstructure, properties and materials, P.K. Mehta and P.J.M. Monteiro, McGraw Hill, 2556.

**c. Other Electronic Resources**

1. Electronic resources on the course area are available at MSRUEAS library

Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Design of Formwork and Precast Structures
Course Code	19TRE525A
Programme	Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course deals with various construction technologies adopted in the construction of different components of Civil Engineering structures. Identification, selection, planning and application of construction formwork and scaffolding technology will be discussed. The various methods, design techniques involved in formwork structures are discussed. Students will also be taught the concepts, classification, planning and design of precast structures.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Compute different types of loads acting on formwork and check for their stability
- CO 2. Design formworks for various civil engineering structures
- CO 3. Propose suitable construction and scaffolding technology for the construction of special structures
- CO 4. Suggest a cost effective solution for usage of equipment, formwork and technology
- CO 5. Compare and contrast the different technologies involved in manufacture, mix design and placement methods of concrete
- CO 6. Classify and design precast elements

### Course Contents

**Unit 1 (Planning, Site Equipment and Plant for formwork):** Forms for foundations, columns, beams, walls, etc., general objectives of formwork building, overall planning, detailed planning, standard units, corner units, pass units; Calculation of labour constants, labour requirements, formwork hours; Overall programme, detailed programme, costing and planning at tender stage, development of a basic system, planning for maximum reuse;

Planning examples, site layout plan, crane arrangements, recheck plan details, planning for safety, transporting plant, formwork beams, scaffold frames, framed panel formwork, wales and ties, vertical transportable frame work, formwork accessories.

**Unit 2 (Materials, Accessories and Proprietary Products):** Lumber- types, finish, sheathing ratio, working stresses, repetitive member stress, plywood- types and grades, jointing, boarding, textured surfaces and strength, reconstituted wood, Steel- aluminium- form lining materials, hardware and fasteners, nails in plywood, allowable withdrawal load and lateral load, pressures on formwork, examples; Vertical loads for design of slab forms, uplift on shores, lateral loads on slabs and walls.

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**Unit 3 (Design Considerations):** Live loads and wind pressure, concrete pressure on formwork, concrete density, height of discharge, temperature, rate of placing, consistency of concrete, vibration, hydrostatic pressure and pressure distribution, examples; Adjustment for non standard conditions, basic simplification, beam forms, slab forms, column forms, wall forms, allowable stresses; Check for deflection, bending and lateral stability shear and bearing, examples in each, simple wood stresses, slenderness ratio, allowable load v/s length behavior of wooden shores

Form lining, design tables for wall framework, slab formwork, column formwork, slab props, stacking towers, free standing and restrained; Rosette shoring, shoring tower, heavy duty props.

**Unit 4 (Formwork Design):** Shell forms- design considerations, loads, building forms, strength requirements, tunnel forming components, curb and gutter forms, invert forms, arch forms, concrete placement methods; Slip forms- principles, types, advantages, functions of various components, planning, safety in slip forms, special structures built with slipform technique, codal provisions; Types of scaffolds- putlog and independent scaffold- single pole scaffolds, fixing ties, spacing of ties, bracing, knots safety net, general safety requirements, shuttering for precast members and continuous casting forms.

**Unit 5 (Building and Erecting the Formwork):** Location of job mill, storage, equipment, form for wall footings, column footings, slab on grade and paving work, highway and airport paving, external vibration, prefabricated panel systems, giant forms, curved wall forms, erection practices, column heads, beam or girder forms, suspended forms, concrete joint construction, flying system forms; Causes of failures- case studies, finishes of exposed concrete, design deficiencies, safety factors, stripping sequence, reshore installation, advantages of reshoring

**Unit 6 (Concept of Prefabricated Construction):** Necessity, advantages, disadvantages, mass produced steel, reinforced concrete and masonry systems, industrial buildings; Concept of modular coordination, basic course, planning and design courses, modular grid systems, National Building Code specifications; Standardization, dimensioning of products, preferred dimensions and sizes, tolerances and deviations, layout and process.

**Unit 7 (Prefabricates Classification):** Foundations, columns, beams, roof and floor panels, wall panels, clay units, box prefabricates in erection and assembly.

Construction techniques: Large panel system, tunnel system, skeletal system, lift slab system, box system, Equipment for horizontal and vertical transportation.

Precast materials and manufacturing: Dry cast concrete, wet cast concrete, self-compacting concrete, sandwich panel construction, precast light concrete, precast ultra concrete, types of surface finishes, supports and fixing.

  
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**Unit 8 (Design of Precast Elements):** Basic design considerations, general design procedure for architectural precast concrete cladding units. Joints and connections: Definition, Basic mechanisms, compression joints, shear joints, tension joints, pinned jointed connections, moment resisting connections

Component design: Design of beams, columns, wall panels, slab footings and their lift point systems.

### Course Resources

#### a. Essential Reading

1. Class Notes
2. Peurifoy R. L. and Oberlender, G. D. (1996), Formwork For Concrete Structures, McGraw Hill
3. Sheppard D. A. and Phillips W. R., (1989), Plant - Cast Precast and Prestressed Concrete : A Design Guide
4. Bachmann H., Steinle A., (2011), Precast Concrete Structures, Ernst and Sohn.

#### b. Recommended Reading

1. Elliot S.K., (2002), Precast Concrete Structures, Butterworth Heinemann
2. PCI Design Handbook Precast and Prestressed Concrete, 6th Edition, PCI Industry Handbook Committee

#### c. Magazines and Journals

1. Precast Inc Magazine., NPCA
2. Precast Solutions Magazine, NPCA
3. CMA Precast Magazines

#### d. Other Electronic Resources

1. <http://nptel.ac.in/>

  
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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Intelligent Transport System
Course Code	19TRCS11A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course deals with Geographic Information System (GIS), remote sensing and its integration with Intelligent Transportation System (ITS). Students will be taught various aspects regarding remote sensing, GIS and ITS. Various techniques in telecommunication in ITS along with its functional areas with operations will be discussed. Students will be trained in data storage analysis, integration of remote sensing and GIS with ITS and advanced applications like Advanced Traveller Information System (ATIS), Automatic Vehicle Location System (AVLS).

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Discuss remote sensing and GIS
- CO 2. Explain ITS and its applications
- CO 3. Apply GIS, remote sensing and ATIS techniques in solving real world transportation problems
- CO 4. Analyse ITS functional areas and its operations
- CO 5. Develop integrated ITS models with GIS
- CO 6. Design and implement ATIS and AVLS

### Course Contents

**Unit 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

**Unit 2 Introduction to GIS:** Basic Concept and Components, Hardware, Software, Data Spatial and non-spatial, Dereferencing, Map Projection, Types of Projection, Simple Analysis, Data retrieval and querying

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

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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

**Unit 3 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

**Unit 4 Introduction to Intelligent Transportation Systems (ITS):** Definition, Objectives, Historical Background, Benefits of ITS -ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

**Unit 5 Telecommunications in ITS** Information Management, Traffic Management Centres (TMC), Application of sensors to Traffic management, Traffic flow sensor technologies, Transponders and Communication systems, Data fusion at traffic management centres, Sensor plan and specification requirements, Elements of Vehicle Location and Route Navigation and Guidance concepts.

**Unit 6 ITS functional areas** Advanced Traffic Management Systems (ATMS), Advanced Traveller Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS). ITS User Needs and Services, Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.

**Unit 7 ITS Operations** Regional and Project ITS architecture, Concept of operations; ITS Models and Evaluation Methods; Planning and human factor issues for ITS, Case studies on deployment planning and system design and operation; ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS planning

**Unit 8 ITS applications:** Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing; Transportation network operations; commercial vehicle operations ; public transportation applications; Automated Highway Systems- Vehicles in Platoons –ITS in World – Overview of ITS implementations in developed countries, ITS in developing countries. [Case study]

Advanced applications: GIS as an integration technology, Integration of GIS and ITS, Advanced Traveller Information System (ATIS), Automatic Vehicle Location System (AVLS)

  
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### Course Resources

#### a. Essential Reading

1. Class Notes
2. Lillesand T. M. and Kiefer R.W., (2000) Remote Sensing and Image Interpretation, John Wiley & Sons
3. Miller H. J. and Shaw S. L., (2001) Geographic Information Systems for Transportation (GIS – T): Principles and Applications, Oxford University Press
4. Williams B., (2008) Intelligent Transport System Standards, Artech House Publisher

#### b. Recommended Reading

1. Reddy A., (1987) Remote Sensing and Image Interpretation, John Wiley and Sons Inc. New York
2. Scholten H. J. and Stillwell J., (2010) Geographical Information Systems for Urban and Regional Planning, Springer
3. Chowdhury M. and Sadek A. W., (2003) Fundamentals of Intelligent Transportation Systems Planning, Artech House

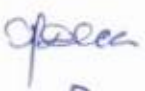
#### c. Magazines and Journals

1. Journal of Intelligent Transportation Systems
2. IEEE Transactions on Intelligent Transportation Systems
3. Journal of Intelligent Transportation and Urban Planning

#### d. Other Electronic Resources

1. Electronic resources on the subject area are available at MSRUAS library

  
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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Railway Engineering
Course Code	19TRC512A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course deals with history on development of railway transport system, components of railway tracks, geometric design of alignment, renewal and maintenance of tracks with railway economics and finance.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Discuss various components of railway tracks
- CO 2. Discuss various types of railway fixtures and fastenings
- CO 3. Analyse construction renewal and maintenance of railways
- CO 4. Develop economics and financial viability of railways
- CO 5. Propose suitable geometrical designs and technologies to be adopted for the construction processes and maintenance railways

### Course Contents

**Unit 1** Development of railway transport system, Railway track and components, Stresses in Railway tracks

**Unit 2** Traction and tractive resistance, Rails, sleepers and ballasts

**Unit 3** Track fitting and fasteners, Railway survey and track alignment

**Unit 4** Railway subgrade and embankment, Geometric design of railway tracks

**Unit 5** Points and crossings, Track junctions

**Unit 6** Station and yards, Railway signals and control systems

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**Unit 7** Construction, renewal and maintenance of railway tracks, Railway track drainage

**Unit 8** Railway safety and track standards, Future trends in modernised railway tracks, Railway economics and finance

### Course Resources

#### a. Essential Reading

1. A text book of Railway Engineering by S C Saxena and S P Arora.
2. Railway Engineering by Satish Chandra and MM Agarwal
3. Railway transportation engineering operation and Management by S Ponnuswamy

#### b. Recommended Reading

1. Antia, K. F.,(1960). Railway Track, New Book Company Pvt. Ltd.
2. Mundrey, J. S.,(2010). Railway Track Engineering. McGraw Hill Publications.

#### c. Magazines and Journals

1. International Journal of Railway Engineering

#### d. Other Electronic Resources

1. <http://onlinepubs.trb.org/onlinepubs/archive/mepdg/home.htm>
2. <http://www.asphaltinstitute.org/thicknessdesignsw/> (30 days trial version)

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Course Title	Airport Engineering
Course Code	19TRC513A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course deals with history on development of airport transport system, components of runways and taxiways, geometric design of alignment, renewal and maintenance of airports, airfield designs, orientation of runways

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Discuss various characteristics of airport
- CO 2. Discuss various components of airport
- CO 3. Design various elements of an airport
- CO 4. Develop methods of orienting runway
- CO 5. Design airfield pavements with FAA and ICAO guidelines.

### Course Contents

**Unit 1** Introduction to air transport, Airport Characteristics

**Unit 2** Airport planning, Airport Obstructions

**Unit 3** Runway Design, Airport Capacity and configuration

**Unit 4** Taxiway Design, Structural design of airport pavements

**Unit 5** Maintenance and rehabilitation of airfield pavements, Terminal area and airport layout

**Unit 6** Visual Aids, Air traffic control

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**Unit 7** Airport grading and drainage, Heliports and their design

**Unit 8** Stolports and their design, Environmental guidelines for airport projects

### Course Resources

#### a. Essential Reading

1. A text book on Airport Planning and Design by S.K. Khanna, M G Arora and S.S.Jain
2. A text book on Airport Engineering: Planning, design and Development of 21st century airports by Norman J Ashford, Saleh Mumayiz and Paul H Wright
3. Airport Engineering, Planning, Design, and Development of 21st Century Airports Norman J. Ashford, Saleh Mumayiz, Paul H. Wright
4. Engineering Pittsburgh A History of Roads, Rails, Canals, Bridges and More

#### b. Recommended Reading

1. Latest FAA Guidelines and Specifications
2. Latest ICAO Guidelines and Specifications
3. Airport Engineering Norman J. Ashford, Paul H. Wright
4. New Frontiers in Road and Airport Engineering, Jianming Ling, Hongduo Zhao, Feipeng Xiao, and Baoshan Huang Lijun Sun

#### c. Magazines and Journals

1. International Journal of Civil Engineering Springer Publications.

#### d. Other Electronic Resources

1. Electronic resources on the subject area are available at MSRUAS library

  
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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Bridge Engineering and Road Projects
Course Code	19TRES31A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course deals with design of various types of bridges and studies essential for a road project. Students will be taught the design of bridges and its foundation. Various traffic and material studies necessary for a road project are explained. Different types of surveys and details essential for the preparation of a Detailed Project Report (DPR) are also discussed.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Discuss the different types of bridges and loads and stresses acting on bridges.
- CO 2. Discuss various surveys and investigations used in feasibility report and detailed project report (DPR).
- CO 3. Design various types of foundation for a bridge structure.
- CO 4. Design various components of RCC and PSC bridges.
- CO 5. Analyse the social and environmental impact of a road project.
- CO 6. Prepare feasibility report and DPR.

### Course Contents

#### Unit 1 Bridge Engineering

Types of Bridges: Consideration of loads and stresses in bridges, bridge loading as per IRC and IRC specifications, traffic lanes, footway, kerbs, railing and parapet loading, impact, wind load, longitudinal forces, temp effects, secondary stresses, erection stresses, earth pressure, effect of live load on back fill and on the abutment.

**Unit 2 Design of RC Bridges:** Slab culvert, box culvert, pipe culvert, T-beam bridge, super structure, design examples, brief introduction to rigid frame, arch and bow string girder bridges. Design of pre-stressed concrete bridges, pre-tensioned and post tensioned concrete bridges, analysis and design of multi-lane pre-stressed concrete T-beam bridge super structure.

**Unit 3 Foundations:** Types, general design criterion, design of well and pile foundations for piers and abutments.

#### Unit 4 Road projects

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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Introduction: Various steps of preparation and execution of road projects, Investigations for preparation of project reports for new and up gradation of roads. Objects and scope of pre – feasibility, feasibility and detailed studies for project preparation.

Typical HR structure for preparations and implementation of road projects

Concepts of Topographic surveys and investigations, Soil investigation, Material surveys and investigations Traffic studies and Traffic forecast.

**Unit 5 Environmental and social impact studies-** assessment relevant to road upgradation / new projects, Mitigation measures, Road safety audit. Collection of relevant data, analysis and interpretation for pre-feasibility and feasibility study reports of the proposed road project. Economic evaluation of different possible alternatives.

Preparation of drawings and project reports. Use of software

**Unit 6 Preparation of DPR-** design details, estimates, BOQ, drawings and detailed project report, use of software

**Unit 7 Planning of Low volume roads:** Introduction to planning of low volume roads, concepts of network planning, selection of roadway alignment, factors affecting rout selection, engineering surveys for new road location.

Recommendations based on IRC SP-20 Rural Road manual

**Course Resources**

**a. Essential Reading**


1. Class Notes
2. Victor D. J., (1980) Essentials of Bridge Engineering, Oxford and IBH.
3. Krishna Raju N., (1988) Design of Bridges, Oxford and IBH.

**b. Recommended Reading**

1. Raina V. K., (2002) Concrete Bridge Practice: Analysis, Design and Economics, Tata McGraw Hill.
2. Fryba L., (1996) Dynamics of Railway Bridges, Thomas Telford.
3. IRC: SP:19 - 2001, Manual for Survey, Investigation and Preparation of Road Projects- (first revision), Indian Roads Congress
4. IRC: SP: 30 - 1993, Manual on Economic Evaluation of Highway- Projects in India (first revision), Indian Roads Congress
5. IRC SP – 38, Manual for Road Investment Decision Model-1992, Indian Roads Congress
6. IRC : 9-1972, 35 – 1997, 38-1988, 39-1986, 52-2001, 54-974, 62-1976, 64-1990, 66-1976, 672001, 69-1977, 73- 1980, 79-1981, 80-1981, 86-1983, 98-1997, 99-1988, 103-1988, 1041988, 110-1996
7. MoRT&H Specifications for Road, Bridge Works- 2001, fourth revision, Indian Roads Congress

  
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**c. Magazines and Journals**

  
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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

1. ASCE Journal of Bridge Engineering
2. The International Journal of Bridge Engineering

**d. Other Electronic Resources**

1. Electronic resources on the course area are available at MSRUAS library

  
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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Harbours and Dock Engineering
Course Code	19TRE532A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

Water transport has always been one of the most dominant means since human evolution. This course deals with the study on general aspects, natural influential phenomena, Classification, planning, design, construction and maintenance of facilities in Harbours, Ports and Dock

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Discuss the general aspects of Harbours, Ports and Dock
- CO 2. The factors influencing Harbours, Ports and Dock
- CO 3. Plan and design the facilities involved in Harbours, Ports and Dock
- CO 4. Construct and maintain the facilities involved in Harbours, Ports and Dock

### Course Contents

#### Unit 1 Harbour and Ports:

Introduction to water transportation, Classification of harbours, Accessibility and size of harbours, Ports in India, Requirements of a good ports and design of ports

#### Unit 2 Natural Phenomena:

General, Littoral drift, Sea water waves, Tide generation, Lunar tides, Solar tides, Major tides, Water level of sea during tides, Uses, Effects, Establishment, Tide predictions, Wind and waves, Dynamical effect of wave action, Modification of sea waves, Air compression, Water hammer, Shore protection.

#### Unit 3 Protection Facilities:

Classification of breakwaters, Heap breakwaters, Selection, Energy dissipation, Characteristics of mound breakwater, Rubble mound, Concrete, Composite breakwater, Construction

Introduction to Wall type breakwater, Types, Failures, Force on upright walls, Essentials, Advantages, Disadvantages, Typical Cross section, Construction, Bonds, Special breakwaters

#### Unit 4 Planning of Ports and docking facilities:

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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Facilities and Layout of ports, Introduction to docks, Classification Advantages and Disadvantages of tidal wet and enclosed wet docks, Form and arrangements, Design and construction.

**Unit 5 Repairing Facilities:**

Classification, Graving dry dock-facilities, Size, Forces acting, Design parameters, Construction, Marine railway dry dock, Slipways, Lift dry dock, Floating type dry dock.

**Unit 6 Approach Facilities:**

Entrance-Direction, Dimensions, Types, Locks-Construction of Lock gates, Shape, Support, Working

**Unit 7 Loading, Unloading and Storing Facilities:**

Quary Walls- Introduction, Types and Design, Wharves, Piers-Introduction, Types, Pier heads, Dolphins, Jetties, Fenders, Slips, Moles, Aprons, Transit sheds, Warehouse, Cold storage, Guard houses

**Unit 8 Dredging and Guiding Facilities:**

Primary dredging, Maintenance, Disposal of dredged material, Dredgers-Types choice and working.

Guiding Facilities-Necessity and types, Lighthouse, Signals- Light, Fog, Audible, Moorings.

**Course Resources**

**a. Essential Reading**

1. Class Notes
2. Harbours, Dock and Tunnel Engineering, R. Srinivasan, Charotar Publications.

**b. Recommended Reading**

1. The Dock And Harbour Engineer's Reference Book, Second Edition
2. Handbook Of Port And Harbour Engineering (Geotechnical And Structural Aspects) Gregory P. Tsinker

**c. Magazines and Journals**

1. Dock and Harbour Authority
2. The Dock and harbour authority. London: Foxlow Publications, Ltd.

**d. Other Electronic Resources**

1. Electronic resources on the course area are available at MSRUAS library

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Course Title	Smart cities and Sustainable Infrastructure
Course Code	19TRE533A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course is to make students understand the concepts and models of 21st century green and smart cities; know current international strategies regarding sustainable development of urban areas. Also the students should be able to learn how to implement sustainability in planning process at different spatial scales.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Discuss the concepts concept and socio-economic policies of Sustainable Development
- CO 2. Discuss the various approaches of energy systems leading to smart city and sustainable planning
- CO 3. Discuss and assess appropriate strategies of eco development , resource conservation and management
- CO 4. Discuss principles and practice of sustainable development, within the context of planning
- CO 5. Recommend techniques and tools used for sustainability planning

### Course Contents

**Unit1 (Introduction):** Understanding Smart Cities; Dimensions of Smart Cities; Global Experience of Smart Cities; Smart Cities–Global Standards and Performance Benchmarks, Practice Codes; India "100 Smart Cities "Policy and Mission; Smart City Planning and Development; Financing Smart Cities Development; Governance of Smart Cities

**Unit 2 (Application of Solar Energy for Smart Cities):** Conventional Vs Smart city components; Energy demand; Green approach to meet Energy demand, Index of Indian cities towards smartness- a statistical analysis; Energy scenarios of conventional cities, its consequences, alternative resources, reliability on predictability scale, solar options, PV and thermal, singular or Hybrid; Meeting energy demand through direct and indirect sources; structure of smart city grid, Indian perspective, advantages and limitations of implementations.

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**Unit3 (Sustainable development):** Introduction to Sustainable Development Concepts and Theory, current urban problems and opportunities, History, definitions, and perspectives on Sustainability Theory and Background to Sustainability Planning,

The Three E's: Environment, Economics, ethics, and ecology of sustainable development.

**Unit 4 (Environment, Ethics and Ecology):** Analyzing the Three E's within an urban development debate, Ethics, Worldviews and Sustainability, Tools for Sustainability Planning: indicators, ecological footprint, other mechanisms, Planning, planners, and sustainability plans; Planning for Sustainability at Different Scales, Regional Planning and Sustainability,

Municipal Planning and Sustainability, Implementing sustainability, Sustainable Transportation Planning, Concept of New Urbanism and Smart Growth.

**Unit 5 (Sustainable materials):** Materials, Energy, and Food, The Natural step, Environmental issues, Concepts and Theory: Industrial Ecology and Green Development; Neighborhood Planning and Sustainability, Ecological Site Design and Architecture, Sustainable building, Green building concept, assessment; International development on Sustainability in Planning, International Institutions; Sustainability Planning in western world, Sustainability Planning in Developing Countries

#### Course Resources

##### a. Essential Reading

1. Class Notes
2. Gilg A. W. and Yarwood R., (2005), Rural Change and Sustainability - Agriculture, the Environment and Communities, CABI Edited by S J Essex
3. Ganesh S., and Sakarama S., Environmental Concerns and Sustainable development: Some perspectives from India, TERI Press, ISBN: 8179932249

##### b. Recommended Reading

1. James H. Weaver, Michael T. Rock, Kenneth Kustere, (1997), Achieving Broad-Based Sustainable Development: Governance, Environment, and Growth with Equity, Kumarian Press, West Hartford, CT.
2. Kirkby. J, O'Keefe P. and Timberlake, (1996), Sustainable development, Earth Scan Publication, London
3. Kerry Turner. R, Sustainable Environmental Management - Principles and Practice, Belhaven Press, ISBN:1852930039.

##### c. Other Electronic Resources

1. <http://nptel.ac.in>

  
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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Environmental Impact assessment of Construction Projects
Course Code	19TRE534A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course provides guidance on Environmental Impact Assessment (EIA) in building construction projects. The course emphasis on the concepts, procedures and tools that are potentially relevant in preparing environmental impact assessment reports for clearance. The course covers a wide range of technical disciplines and students will gain the ability to describe, improve and suggest alternatives for the construction project to be more environmentally sustainable

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Discuss the importance of EIA as an integral part of planning process of construction project
- CO 2. Discuss methodologies to predict and assess the impacts of project on various aspects of Environment
- CO 3. Discuss the role of public participation in environmental decision making process
- CO 4. Emphasis on environmental management plan and environmental health safety at construction project

### Course Contents

#### Unit 1 Introduction

General Information on Building Construction, Environmental Clearance Process, Terms of Reference (TOR), Validity of Environmental Clearance, Post Environmental Clearance Monitoring, Transferability of Environmental Clearance, Generic Structure of Environmental Impact Assessment Document, Identification of Project Proponent

#### Unit 2 Description of Project Environment

Description of the Project, Site Selection, Manpower Requirement, Project Implementation Schedule Land Environment, Water Environment, Air Environment, Noise Environment, Biological Environment, Socio-economic Environment, Solid Waste, Environmental Impact Analysis and Mitigation Measure

#### Unit 3 Analysis of Alternatives -Technology and Site

Building Materials, Energy Conservation, Transportation, Environmental Monitoring Program, Risk Assessment and Disaster Management Plan (DMP), Natural Resource Conservation, R&R Action Plan

#### Unit 4 Potential Environmental Impacts

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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Introduction, Anticipated Environmental Impacts, Positive & Negative Environmental Impacts of Construction Activities, Operational Activities, Decommissioning Activities, impacts mitigation measures

#### Unit 5 Environmental Management Plan

Environmental Monitoring and Evaluation, EHS Management and Administration , Policy, Administrative and Legislative Framework ,Organization and implementation of the EHS Management Plan ,The Guiding Principles to be adopted , EHS management strategy to be adopted, Safety Agenda for both the proponent and contractor , Safety requirement at the project site during construction and operation Period, Welding at the construction site Emergency procedure during construction and operation, Decommissioning

#### Course Resources

##### a. Essential Reading

1. Class Notes
2. Environmental Impact Analysis Handbook by Rau Whooten; McGraw Hill publications
3. Environmental Impact Assessment by Larry Canter; McGraw Hill publications

##### b. Recommended Reading

1. Environmental Impact Analysis – A Decision Making Tool by R K Jain
2. Handbook of Environment Impact Assessment by Judith Petts; McGraw Hill publications

##### c. Magazines and Journals

1. <http://environmentclearance.nic.in/>

##### d. Other Electronic Resources

1. <http://environmentclearance.nic.in/>
2. Electronic resources on the course area are available at MSRUAS library

  
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Course Title	Applications of AI in Transportation Engineering
Course Code	19TRES41A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course introduces the basic concepts and techniques of Artificial Intelligence (AI). Topics covered are Expert systems, uncertainty, Neural Network, and fuzzy Logic, and their applications of AI in Transportation Engineering.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Explicate characteristics of AI that make it useful to real-world civil engineering problems, different causes of structural failures of buildings, bridges and other constructed facilities, sensors
- CO 2. Discuss applications of AI in traffic and transportation engineering
- CO 3. Discuss Artificial Neural Network (ANN), Fuzzy logic (FL) and expert systems (ES), sensors and Data acquisition systems and their applications in specialisations of civil engineering
- CO 4. Apply concepts of ANN, FL and ES in specializations of Civil Engineering

### Course Contents

**Unit 1** Explicate characteristics of AI that make it useful to real-world civil engineering problems, different causes of structural failures of buildings, bridges and other constructed facilities, sensors

**Unit 2** Discuss applications of AI in traffic and transportation engineering

**Unit 3** Discuss Artificial Neural Network (ANN), Fuzzy logic (FL) and expert systems (ES), sensors

**Unit 4** Data acquisition systems and their applications in specialisations of civil engineering

**Unit 5** Apply concepts of ANN, FL and ES in specializations of Civil Engineering

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### Course Resources

#### a. Essential Reading

1. Class Notes
2. Krishnamoorthy C.S., Rajeev S., (1996) Artificial Intelligence and Expert Systems for Engineers, CRC Press, CRC Press LLC
3. Rajasekaran S. and Vijayalakshmi Pai G.A., (2005) Neural Network, Fuzzy Logic, and Genetic Algorithms - Synthesis and Applications, Prentice Hall
4. Adeli H., Karim A., (2001) Construction scheduling , cost optimisation, and management, Spon Press, New York

#### b. Recommended Reading

1. Winston P.H., (1999) Artificial Intelligence, Pearson Education
2. Lugur G. F., (2002) Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Addison – Wesley
3. Russel S. and Norvig P., (2002) Artificial Intelligence: A Modern Approach, Prentice Hall

#### c. Other Electronic Resources

1. Electronic resources on the course area are available at MSRUA library

  
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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Pavement Construction Evaluation Maintenance and Management System
Course Code	19TRES42A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

The role of properly timed and qualitatively controlled rehabilitation and maintenance measures in preserving a pavement's surface quality and ensuring that the structure lasts in serviceable condition through its design life and beyond is well recognized. This course explores the methods of structural and functional evaluation of flexible and rigid pavements for gathering critical data on the condition of pavements to enable strategic decision making with regard to rehabilitation/maintenance measures under budgetary constraints. Detailed introduction to pavement management system (PMS), which includes life cycle cost analysis, ranking of maintenance and rehabilitation projects, various approaches to PMS, PMS software and PMS implementation.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Discuss various distresses observed in pavements
- CO 2. Design various types of flexible and rigid pavement and overlays for different site condition
- CO 3. Recommend the material of construction, type of pavement, method of construction or maintenance specific to the site
- CO 4. Analyze pavement management system and its implementation using HDM
- CO 5. Analyze the various defects of pavement and suggest suitable maintenance method

### Course Contents

#### Unit 1 Pavement evaluation and maintenance

Pavement Inventories, Quality Control and Evaluation Serviceability Concepts ;Visual Rating ;Pavement Serviceability Index; Roughness Measurements ;Distress Modes – Cracking Rutting; Pavement Deflection – Different Methods and BBD, Skid Resistance, Roughness, Safety – Aspects; Inventory System. Causes of Deterioration, Traffic and Environmental Factors, Pavement Performance Modelling Approaches and Methods of Maintaining WBM, Bitumen and Cement Concrete Roads, Quality Assurance; Quality Control – ISO:9000 , Sampling Techniques – Tolerances and Controls related to Profile and Compaction.

Unit 2 Structural and functional requirements of flexible and rigid pavements, pavement distress, different types of failures, causes.

Unit 3 Evaluation of Surface Condition: Methods of measurement of skid resistance, unevenness, ruts and cracks. Pavement surface condition evaluation by physical measurements, by riding comfort and other methods, their applications.

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**Unit 4 Evaluation of Pavement Structural Condition:** Evaluation by non-destructive tests such as FWD, Benkelman Beam rebound deflection using BBD for flexible overlay design, Plate load test, wave propagation and other methods of load tests, evaluation by destructive test methods, and specimen testing.

- (a) Functional Evaluation
- (b) Structural Evaluation
- (c) Non-Destructive Tests

**Unit 5 Pavement Maintenance:** Routine maintenance, periodic maintenance, special repairs, rehabilitation and reconstruction.

**Unit 6 Pavement Maintenance & Management Process:** Application of system concepts to pavement management, pavement management levels-Network & Project level, functions - Data needs, Pavement life cycle, assessment of pavement performance, evaluation of pavement structural capacity, distress & safety, combined measures of pavement quality, data management

**Unit 7 Determining Present and Future Needs:** Establishing criteria – development of models for pavement deterioration – determining the future needs – rehabilitation and maintenance strategies – developing combined programmes for maintenance & rehabilitation

**Unit 8 Implementation:** Major steps in implementing PMS – pavement construction management & pavement maintenance management – information's, research needs – cost and benefit of pavement management – future directions and need for innovations in pavement management, HDM applications

#### Course Resources

##### a. Essential Reading

- 1. Class Notes
- 2. Pavement management systems – Haas and Hudson, W. R.-McGraw Hill publication

##### b. Recommended Reading

- 1. Pavements and surfacing for highways and airports – Sargious, M. A. – Applied Science Publishers Ltd
- 2. Bridge and Pavement maintenance- Transportation Research Record no.800, TRB
- 3. Pavement management for airports, roads and parking lots- Shahin M.Y
- 4. Highway and Traffic engineering for developing countries-Bent Thagesan
- 5. MORT&H – Specifications

##### c. Other Electronic Resources

- 1. Electronic resources on the course area are available at MSRUEAS library.

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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Highway Economics, Finance and Road Safety
Course Code	19TRE543A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course deals with the economic and financial features of road project. Students will be taught various aspects of economic evaluation and different methods of financial analysis. Students will also be taught about the road safety engineering and certain aspects of road safety audit. Students will also be introduced to the mitigation measures with respect to road safety.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Understand the principles of highway economics and finance
- CO 2. Apply economics for different types of highway projects.
- CO 3. Analyse for economic and financial feasibility of highway projects.
- CO 4. Evaluate techno-economic feasibility of highway projects
- CO 5. To appraise the road safety audit and suggest suitable mitigation measures.

### Course Contents

#### Unit 1 Highway Economics

Highway Economics -Principle, supply and demand models, equilibrium, sensitivity of travel demand, Elasticities – types, models (Kraft demand model) consumer surplus cost – cost elasticity pricing and subsidy policies, rates of interest, Vehicle operation cost, direct and indirect benefits due to road improvement, Total transportation cost, fixed and variable costs. Road user cost studies in India.

**Economic analysis**, different methods, determination of annual cost, benefit cost ratio, IRR, FIRR, NPV. Sensitivity of economic analysis, Examples of economic analysis for different types of road improvement measures, pavement options, construction of bypasses and upgrading of intersections. Project priorities, methods of dealing with uncertainties.

  
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#### Unit 2 Highway financing

  
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Highway financing- various options for road and bridge projects, special cess, tolling, BOT, BOOT and other options. Economic and financial analysis of highway projects and use of computer software packages. Road investment decision packages.

### Unit 3 Road Safety Engineering:

Introduction to safety: Road accidents, Trends, causes, Collision and Condition diagrams, Highway safety, human factors, Vehicle factors Road Safety Management System: Multicausal dynamic systems approach to safety, crash vs accident, road safety improvement strategies, elements of a road safety plan, Safety Data Needs.

Statistical Interpretation and Analysis of Crash Data: Before-after methods in crash analysis, Advanced statistical methods, Black Spot Identification & Investigations, Case Studies.

### Unit 4 Road Safety Audits

Key elements of a road safety audit, Road Safety Audits & Investigations, Crash investigation and analysis, Describe methods for identifying hazardous road locations, Case Studies.

**Crash Reconstruction:** Describe the basic information that can be obtained from the roadway surface, Understand basic physics related to crash reconstruction, speed for various skid, friction, drag, and acceleration scenarios, variables involved in jump and flip crashes, variables involved in pedestrian crashes, Case Studies.

### Unit 5 Mitigation Measures

Accident prevention by better planning, Accident prevention by better design of roads, Crash Counter measures, Highway operation and accident control measures, Highway Safety Measures during construction, Highway geometry and safety.

## Course Resources

### a. Essential Reading

1. Kadiyali L.R. "Traffic Engineering and Transport Planning"-Khanna Publishers, New Delhi.
2. Jotin Chisty.C and Kent Lall B "Transportation Engineering An Introduction"- PHI, New Delhi.
3. Prasanna Chandra "Financial Management"-Tata McGraw, New Delhi.

### b. Recommended Reading

1. Oods K.B, Berry, D.S. and Goetz W.H, "Highway Engineering"-McGraw Hill Book Co.
2. Hewes C.I. and Oglesby, C.H., "Highway Engineering"-Asia Publishing House.
3. Ian G. Heggie, "Transportation Engineering Economics"-McGraw Hill Book Co.
4. "Road User Cost Study in India", Final Report, Central Road Research Institute, New Delhi, 1982.

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5. Kadiyali, L.R., et al, "Value of Travel Time Savings" - Traffic Engineering, HRB
6. Ministry of Road Transport and Highways, "Road Development Plan for India"- 2001-2021, Indian Roads Congress, New Delhi, 2002.
7. Ezra Hauer, Observational Before-After Studies in Road Safety, Pergamon Press, 1997 (reprinted 2002)
8. Institute of Transportation Engineers (ITE), The Traffic Safety Toolbox: A Primer on Traffic Safety, ITE, 1999.
9. J. Stannard Baker, Traffic Collision Investigation, Northwestern University Center for Public Safety, 2002.
10. Leonard Evans, Traffic Safety, Science Serving Society, 2004. Lynn B. Fricke, Traffic Accident Reconstruction, Northwestern University Center for Public Safety, 1990.
11. Ogden, K.W. Safer Roads: A Guide to Road Safety Engineering. Avebury Technical, 1996.
12. Popkess C.A, Traffic Control and Road Accident Prevention, Chapman and Hall, 1997 Rune Elvik and Truls Vaa, The Handbook of Road Safety Measures, Elsevier, 2004.
13. Simon Washington, Matthew Karlaftis, and Fred Mannering, Statistical and Econometric Methods for Transportation Data Analysis, Chapman & Hall/CRC Press, 2003.
14. Towards Safe Roads in Developing country, TRL – ODA, 2004

**c. Magazines and Journals**

1. Journal of Transportation Research Board
2. Indian Road Congress journals

**d. Other Electronic Resources**

1. <http://onlinepubs.trb.org/onlinepubs/archive/mepdg/home.htm>

  
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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Construction Equipment Management
Course Code	19TRE544A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

This course deals with the various types of construction equipments and machineries. Students will be taught about selection of suitable equipments for a particular work. Students will also be taught about management of these construction equipments in the projects.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Achieve Knowledge of Planning and management of construction Equipments.
- CO 2. Understand the selection of equipments used for construction.
- CO 3. Develop equipment management skills.
- CO 4. Summarize the solution of Equipment inventory.
- CO 5. Manage construction equipments in projects to enhance the efficiency

### Course Contents

#### Unit 1: Plants and Equipment for production of materials

Crushers, mixers, bituminous mixing plants, concrete mixing plants, transit mixers, advantages, choice, production rate calculation

#### Unit 2: Construction Equipment

Operations, applications and performance of dozers, excavators, graders, compactors, pavers, haulers, crawler, wheel tractors, power shovels, pile driving equipments, hauling equipments, and drilling, blasting and tunnelling equipment.

#### Unit 3: Miscellaneous Equipment

Equipment for: Dredging, tunnelling, dewatering. Equipment for flooring dewatering and floors finishing. Sprayers, kerb casting equipment, screening equipment.

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**Unit 4: Selection of Construction Equipment**

Task considerations, cost considerations, engineering considerations, equipment acquisition options.

**Unit 5: Equipment management in Construction Projects**

Equipment planning, extent of mechanism. Forecasting equipment requirement, output and capacity, utilization and time period, operation planning. Manpower planning. Selection of equipment, forward planning. Purchase of equipment. Workshop installation and spare part management. Maintenance management. Down time availability. Operation and utilization. Equipment replacement. Latest management techniques- network technique, work study, operation research, communication, computerization, value engineering, cost control, cost accounting, training equipment operators. Decision Making.

**Course Resources**

**a. Essential Reading**

1. Peurifoy, R.L., Ledbette. W.B., Construction Planning, Equipment and Methods, McGraw Hill Co.,
2. SC Sharma 'Construction equipment' 5. Chitkara, K. K. Construction Project Management: Panning, Scheduling and Control, Tata McGraw Hill Publishing Company, New Delhi,1998.

**b. Recommended Reading**

1. Antil J.M., Civil Engineering Construction, McGraw Hill Book Co.
2. Smith, R.C, Andres, C.K., Principles and Practive of Heavy Construction, Prentice Hall

**c. Magazines and Journals**

1. Journal of construct engineering and management - ASCE
2. Journal of Transportation Research Board
3. Indian Road Congess journals

**d. Other Electronic Resources**

1. <http://onlinepubs.trb.org/onlinepubs/archive/mepdg/home.htm>

  
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Program Structure and Course details of M.Tech in Transportation Engineering 2022-24

Course Title	Internship
Course Code	19TRPS01A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

### Course Summary

The aim of this course is to make a student experience an industrial or business environment. The student will visit various departments of an industry/business and observe the activities in each department for a certain duration of time and try to relate his/her experience with the theory practiced back at the faculty. The student should develop a report and make a presentation on his/her experience at the industry/business.

### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Describe the organization structure of the industry/business
- CO 2. Identify Business objectives of the organization
- CO 3. Describe the various departments of the organization and their activities and Responsibilities to meet the business objectives
- CO 4. Discuss the limitations and new opportunities for growth of the organization
- CO 5. Express the education and skill requirement of graduates to pursue their career in Industry

### Course Contents

Industry Internship in the relevant organization

### Course Resources

#### a. Essential Reading

1. Organization website
2. Discussions with Managers/Mentor/Supervisor of different departments of the organization

#### b. Other Electronic Resources

1. Electronic resources on the subject area are available at MSRUAS library.

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Course Title	Group Project
Course Code	19TRP502A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

#### Course Summary

This course is intended to provide student an opportunity to synergise their learning from the earlier courses through working in a team, sharing responsibilities, to conceiving, designing and fabricating a working prototype of a system related to an automotive application. The students will learn skills related to project identification, planning, management and execution, working in teams and verbal and written communication. During design, analysis and synthesis stage, they will get an opportunity to apply theoretical knowledge to develop real life product and prototyping stage will provide them experience of converting a design into a working system through use of various fabrication techniques available.

#### Course Outcomes

After undergoing this course students will be able to:

- CO 1. Work in a team and undertake a project in the area of Transportation Engineering
- CO 2. Apply Transportation Engineering methodologies and reconfigurable techniques for Executing road project
- CO 3. Apply appropriate research methodology while formulating a project
- CO 4. Define Specifications, Synthesize, Analyse, Develop and Evaluate a project
- CO 5. Develop a video which explains the project, exhibit, make a presentation and Document the work

#### Course Contents

Need for undertaking a project, design specifications, design, analysis, design evaluation and presentation.

Project Management Costing, Construction, Procurement, Project Development, Testing, Project Evaluation, Exhibition, Presentation.

Team building, Team work, Leadership skills.

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**Course Resources**

**a. Essential Reading**

1. Assigned reading relevant to the group project.

**b. Other Electronic Resources**

1. Electronic resources on the subject area are available at MSRUAS library

  
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Course Title	Dissertation and Publication
Course Code	19TRP522A
Programme	M.Tech in Transportation Engineering
Department	Civil Engineering
Faculty	Faculty of Engineering and Technology

#### Course Summary

This course is intended to give an insight to the students on application of principles of research methodology, preparation of research project proposal, research project management, execution of research project and effective technical communication and presentation. It also emphasizes the need and the relevance of a structured approach to identify a research topic and undertake research. This course provides an opportunity for students to apply theories and techniques learnt during programme work. It involves in-depth work in the chosen area of study.

#### Course Outcomes

After undergoing this course students will be able to:

- CO 1. 1.Critically review scholarly literature collected from various sources for the project Purpose and formulate a research problem
- CO 2. Prepare and present a research proposal
- CO 3. Conduct research to achieve research objectives
- CO 4. Propose new ideas/methodologies or procedures for further improvement of the Research undertaken
- CO 5. Create research document and write research papers for publications
- CO 6. Defend the research findings in front of scholarly audience

#### Course Contents

- Research Methodology
- Information search, retrieval and review
- Project definition and project planning
- Use of conceptual models and frameworks
- Problem solving and Evaluation
- Interpretations and drawing conclusions
- Proposing ideas or methods for further work
- Thesis writing
- Oral presentation
- Authoring Research paper

  
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**Course Resources**

**a. Essential Reading**

1. Lecture Sessions on Dissertation, Thesis Preparation delivered by the concerned Head of Dept.

**b. Other Electronic Resources**

1. Electronic resources on the subject area are available at MSRUAS library

  
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