REVA UNIVERSITY
Bengaluru, India

SCHOOL OF CIVIL ENGINEERING

HANDBOOK

M. Tech. in Transportation Engineering and Management

2020-22

Rukmini Knowledge Park,
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Phone No: +91-080-46966966

Rukmini Educational
Charitable Trust

www.reva.edu.in

Chancellor's Message

"Education is the most powerful weapon which you can use to change the world."
- Nelson Mandela.

There was a time when survival depended on just the realization of physiological needs. We are indeed privileged to exist in a time when 'intellectual gratification' has become indispensable. Information is easily attainable for the soul that is curious enough to go look for it. Technological boons enable information availability anywhere anytime. The difference, however, lies between those who look for information and those who look for knowledge.

It is deemed virtuous to serve seekers of knowledge and as educators it is in the ethos at REVA University to empower every learner who chooses to enter our portals. Driven by our founding philosophy of 'Knowledge is power', we believe in building a community of perpetual learners by enabling them to look beyond their abilities and achieve what they assumed impossible.

India has always been beheld as a brewing pot of unbelievable talent, acute intellect and immense potential. All it takes to turn those qualities into power is a spark of opportunity. Being at a University is an exciting and rewarding experience with opportunities to nurture abilities, challenge cognizance and gain competence.

For any University, the structure of excellence lies in the transitional abilities of its faculty and its facility. I'm always in awe of the efforts that our academic board puts in to develop the team of subject matter experts at REVA. My faculty colleagues understand our core vision of empowering our future generation to be ethically, morally and intellectually elite. They practice the art of teaching with a student-centered and transformational approach. The excellent infrastructure at the University, both educational and extra-curricular, magnificently demonstrates the importance of ambience in facilitating focused learning for our students.

A famous British politician and author from the 19th century - Benjamin Disraeli, once said 'A University should be a place of light, of liberty and of learning'. Centuries later this dictum still inspires me and I believe, it takes team-work to build successful institutions. I welcome you to REVA University to join hands in laying the foundation of your future with values, wisdom and knowledge.

Dr. P. Shyama Raju
The Founder and Hon'ble Chancellor, REVA University

Vice-Chancellor's Message

The last two decades have seen a remarkable growth in higher education in India and across the globe. The move towards inter-disciplinary studies and interactive learning have opened up several options as well as created multiple challenges. India is at a juncture where a huge population of young crowd is opting for higher education. With the tremendous growth of privatization of education in India, the major focus is on creating a platform for quality in knowledge enhancement and bridging the gap between academia and industry.

A strong believer and practitioner of the dictum "Knowledge is Power", REVA University has been on the path of delivering quality education by developing the young human resources on the foundation of ethical and moral values, while boosting their leadership qualities, research culture and innovative skills. Built on a sprawling 45 acres of green campus, this 'temple of learning' has excellent and state-of-the-art infrastructure facilities conducive to higher teaching-learning environment and research. The main objective of the University is to provide higher education of global standards and hence, all the programs are designed to meet international standards. Highly experienced and qualified faculty members, continuously engaged in the maintenance and enhancement of student-centric learning environment through innovative pedagogy, form the backbone of the University.

All the programs offered by REVA University follow the Choice Based Credit System (CBCS) with Outcome Based Approach. The flexibility in the curriculum has been designed with industry-specific goals in mind and the educator enjoys complete freedom to appropriate the syllabus by incorporating the latest knowledge and stimulating the creative minds of the students. Bench marked with the course of studies of various institutions of repute, our curriculum is extremely contemporary and is a culmination of efforts of great think-tanks - a large number of faculty members, experts from industries and research level organizations. The evaluation mechanism employs continuous assessment with grade point averages. We believe sincerely that it will meet the aspirations of all stakeholders – students, parents and the employers of the graduates and postgraduates of Reva University.

At REVA University, research, consultancy and innovation are regarded as our pillars of success. Most of the faculty members of the University are involved in research by attracting funded projects from various research level organizations like DST, VGST, DBT, DRDO, AICTE and industries. The outcome of the research is passed on to

students through live projects from industries. The entrepreneurial zeal of the students is encouraged and nurtured through EDPs and EACs.

REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students become skilled with relevant to industry requirements. Structured training programs on soft-skills and preparatory training for competitive exams are offered here to make students more employable. 100% placement of eligible students speaks the effectiveness of these programs. The entrepreneurship development activities and establishment of "Technology Incubation Centers" in the University extend full support to the budding entrepreneurs to nurture their ideas and establish an enterprise.

With firm faith in the saying, "Intelligence plus character –that is the goal of education" (Martin Luther King, Jr.), I strongly believe REVA University is marching ahead in the right direction, providing a holistic education to the future generation and playing a positive role in nation building. We reiterate our endeavor to provide premium quality education accessible to all and an environment for the growth of over-all personality development leading to generating "GLOBAL PROFESSIONALS"

Welcome to the portals of REVA University!

Dr. M Dhanamjaya,
Vice Chancellor,
REVA University.

Director's Message

The M.Tech in Transportation Engineering and Management is designed keeping in view the current situation and possible future developments, both at national and global levels. This course is designed to give greater emphasis on core Transportation Engineering. There are ample number of courses providing knowledge in specialized areas of Transportation Engineering. facilitating students to choose specialized areas of their interest. Adequate attention is given to provide students the basic concepts.

Transporation engineering and Management is one of the earliest to start among the core subjects. The structure of the course has undergone a face-lift with the introduction of subjects from latest advanced subjects like Town Planning, Urban Transport Planning, Prestressed & Precast Structures, Solid Waste Management, Industrial Waste Water Treatment etc. Thus the Civil Engineering stream is designed to provide you with several options to choose from for your later years. The Indian government having plans to adopt make in India concept in this major is infrastructure development. Hence Infrastructure development sector offers lots of job opportunities for well qualified graduates.

The program is thus designed to expose students to various subjects having hand on applications in planning, design & construction, through outcome based teaching and learning process which emphasizes practical exposure rather than memorization. A variety of activities such as mini projects, seminars, interaction with industries, cultural activities and social activities are in place to shape the all-round development of students.

- **Transportation Engineering**- to resolve the current traffic problems and plan for the future requirements of the society.

The benefits of choosing Transportation Engineering and Management are:

- Flexibility to choose various fields upon graduation.
- Opportunity to work on live problems.
- Opportunity to work on latest technologies.
- Opportunity for designers & planner to plan & design live projects.

I am sure the students choosing M Tech in Transportation Engineering and Management in REVA University will enjoy the curriculum, teaching and learning environment, the vast infrastructure and the experienced teachers involvement and guidance. The cirruculum caters to and has relevance to local, regional, national, global developmental needs. We will strive to provide all needed comfort and congenial environment for their studies.

Maximum number of courses are integrated with cross cutting issues with relevant to professional ethics, Gender, human values, environment and Sustainability. I wish all students pleasant stay in REVA and grand success in their career. We will strive to provide all needed comfort and congenial environment for their studies. I wish all students pleasant stay in REVA and grand success in their career. We will strive to provide all needed comfort and congenial environment for their studies. I wish all students pleasant stay in REVA and grand success in their career.

Dr. Y. Ramalinga Reddy
Director
School of Civil Engineering

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RUKMINI EDUCATIONAL CHARITABLE TRUST

It was the dream of late Smt. Rukmini Shyama Raju to impart education to millions of underprivileged children as she knew the importance of education in the contemporary society. The dream of Smt. Rukmini Shyama Raju came true with the establishment of Rukmini Educational Charitable Trust (RECT), in the year 2002. **Rukmini Educational Charitable Trust** (RECT) is a Public Charitable Trust, set up in 2002 with the objective of promoting, establishing and conducting academic activities in the fields of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology, among others. In furtherance of these objectives, the Trust has set up the REVA Group of Educational Institutions comprising of REVA Institute of Technology & Management (RITM), REVA Institute of Science and Management (RISM), REVA Institute of Management Studies (RIMS), REVA Institute of Education (RIE), REVA First Grade College (RFGC), REVA Independent PU College at Kattigenahalli, Ganganagar and Sanjaynagar and now REVA University. Through these institutions, the Trust seeks to fulfill its vision of providing world class education and create abundant opportunities for the youth of this nation to excel in the areas of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology.

Every great human enterprise is powered by the vision of one or more extraordinary individuals and is sustained by the people who derive their motivation from the founders. The Chairman of the Trust is Dr. P. Shyama Raju, a developer and builder of repute, a captain of the industry in his own right and the Chairman and Managing Director of the DivyaSree Group of companies. The idea of creating these top notched educational institutions was born of the philanthropic instincts of Dr. P. Shyama Raju to do public good, quite in keeping with his support to other socially relevant charities such as maintaining the Richmond road park, building and donating a police station, gifting assets to organizations providing accident and trauma care, to name a few.

The Rukmini Educational Charitable Trust drives with the main aim to help students who are in pursuit of quality education for life. REVA is today a family of ten institutions providing education from PU to Post Graduation and Research leading to PhD degrees. REVA has well qualified experienced teaching faculty of whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 13,000 students study various courses across REVA's three campuses equipped with exemplary state-of-the-art infrastructure and conducive environment for the knowledge driven community.

ABOUT REVA UNIVERSITY

REVA University has been established under the REVA University Act, 2012 of Government of Karnataka and notified in Karnataka State Gazette No. 80 dated 27thFebruary, 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

REVA University located in between Kempegowda International Airport and Bangalore city, has a sprawling green campus spread over 45 acres of land and equipped with state-of-the-art infrastructure that provide conducive environment for higher learning and research. The REVA campus has well equipped laboratories, custom-built teaching facilities, fully air-conditioned library and central computer centre, the well planned sports facility with cricket ground, running track & variety of indoor and outdoor sports activities, facilities for cultural programs. The unique feature of REVA campus is the largest residential facility for students, faculty members and supportive staff.

REVA consistently ranked as one of the top universities in various categories because of the diverse community of international students and its teaching excellence in both theoretical and technical education in the fields of Engineering, Management, Law, Science, Commerce, Arts, Performing Arts, and Research Studies. REVA offers 28 Undergraduate Programmes, 22 Full-time and 2 Part-time Postgraduate Programmes, 18 Ph. D Programmes, and other Certificate/ Diploma/Postgraduate Diploma Programmes in various disciplines.

The curriculum of each programme is designed with a keen eye for detail by giving emphasis on hands-on training, industry relevance, social significance, and practical applications. The University offers world-class facilities and education that meets global standards.

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance. Highly qualified, experienced faculty and scholars from reputed universities / institutions, experts from industries and business sectors have contributed in preparing the scheme of instruction and detailed curricula for this program. Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education has been introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. The system also allows students to move forward under the fast track for those who have the capabilities to surpass others. These

programs are taught by well experienced qualified faculty supported by the experts from industries, business sectors and such other organizations. REVA University has also initiated many supportive measures such as bridge courses, special coaching, remedial classes, etc., for slow learners so as to give them the needed input and build in them confidence and courage to move forward and accomplish success in their career. The University has also entered into MOUs with many industries, business firms and other institutions seeking their help in imparting quality education through practice, internship and also assisting students' placements.

REVA University recognizing the fact that research, development and innovation are the important functions of any university has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology and other areas of study. The interdisciplinary-multidisciplinary research is given the top most priority. The division continuously liaisons between various funding agencies, R&D Institutions, Industries and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Data Mining, Cloud Computing, Image Processing, Network Security, VLSI and Embedded Systems, Wireless Censor Networks, Computer Networks, IOT, MEMS, Nano- Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, LED Lightings, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nana Tribology, Fuel Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

The REVA University has also given utmost importance to develop the much required skills through variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and Placement (CDC) department with world class infrastructure, headed by a dynamic experienced Professor& Dean, and supported by well experienced Trainers, Counselors and Placement Officers.

The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been recognised as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation)

under Pradhan Mantri Kaushal VikasYojana. The Centre conducts several add-on courses in challenging areas of development. It is always active in facilitating student's variety of Skill Development Training programs.

The University has collaborations with Industries, universities abroad, research institutions, corporate training organizations, and Government agencies such as Florida International University, Okalahoma State University, Western Connecticut University, University of Alabama, Huntsville, Oracle India Ltd, Texas Instruments, Nokia University Relations, EMC^2, VMware, SAP, Apollo etc, to facilitate student exchange and teacher–scholar exchange programs and conduct training programs. These collaborations with foreign universities also facilitates students to study some of the programs partly in REVA University and partly in foreign university, viz, M.S in Computer Science one year in REVA University and the next year in the University of Alabama, Huntsville, USA.

The University has also given greater importance to quality in education, research, administration and all activities of the university. Therefore, it has established an independent Internal Quality division headed by a senior professor as Dean of Internal Quality. The division works on planning, designing and developing different quality tools, implementing them and monitoring the implementation of these quality tools. It concentrates on training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and successful industrialists, entrepreneurs, scientists and such others from time to time. As a part of this exercise great personalities such as Bharat Ratna Prof. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr. Balaram, Former Director IISc., and noted Scientist, Dr. V S Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of Defence Dr. Sathish Reddy, Scientific Advisor, Ministry of Defence, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

REVA organises various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events the students are given opportunities to unfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is REVAMP conducted every year. The event not only gives opportunities to students of REVA but also students of other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion,

Seminars, exhibitions and variety of cultural events. Another important event is Shubha Vidaaya, - Graduation Day for the final year students of all the programs, wherein, the outgoing students are felicitated and are addressed by eminent personalities to take their future career in a right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. During this occasion, the students who have achieved top ranks and won medals and prizes in academic, cultural and sports activities are also recognised by distributing awards and prizes. The founders have also instituted medals and prizes for sports achievers every year. The physical education department conducts regular yoga class'severyday to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

Vision

'REVA University aspires to become an innovative university by developing excellent human resources with leadership qualities, ethical and moral values, research culture and innovative skills through higher education of global standards".

Misson

- To create excellent infrastructure facilities and state-of-the-art laboratories and incubation centers
- To provide student-centric learning environment through innovative pedagogy and education reforms
- To encourage research and entrepreneurship through collaborations and extension activities
- To promote industry-institute partnerships and share knowledge for innovation and development
- To organize society development programs for knowledge enhancement in thrust areas
- To enhance leadership qualities among the youth and enrich personality traits, promote patriotism and moral values.

Objectives

- Creation, preservation and dissemination of knowledge and attainment of excellence in different disciplines
- Smooth transition from teacher - centric focus to learner - centric processes and activities
- Performing all the functions of interest to its major constituents like faculty, staff, students and the society to reach leadership position
- Developing a sense of ethics in the University and Community, making it conscious of its obligations to the society and the nation
- Accepting the challenges of globalization to offer high quality education and other services in a competitive manner

ABOUT SCHOOL OF CIVIL ENGINEERING

The School of Civil Engineering is headed by highly experienced Professor and is supported by well qualified faculty members. The school has the state-of-art class rooms and well equipped laboratories. It offers B.Tech and M.Tech programs in various specialized streams. The school also has research program leading to doctoral degree. The curriculum of both graduate and post graduate degree programs have been designed to bridge the gap between industry – academia and hence they are industry application oriented. The B.Tech program aims to prepare human resources to play a leading role in the competitive construction field and excel in their endeavors. The Master's Degree programs focus on research and design in the core and Computer Aided Structural Engineering, Construction technology & management and Transportation Engineering & Management to supplement and create a sustainable world and to enhance the global quality of life by adopting enhanced techniques of design and application. This is reflected in various core subjects offered within the program. Currently Civil Engineering teaching was limited to planning, analysis, design and execution of different types of infrastructure like buildings, roads, bridges, dams and power plants. However, due to increase of technological sophistication and demand for higher living standards geared up by economic growth and concerns about environmental impact have changed the scope of Civil Engineering. The challenges of today's Civil Engineering infrastructure are much more complex and interdependencies between resources.

Even though there are a large number of institutions in the country which are producing Civil Engineers, there is acute shortage of quality Civil Engineers. The REVA UNIVERSITY would like to offer Civil Engineering Programme to produce quality engineers who are effective and efficient in problem solving and providing economical and sustainable infrastructural solutions.

VISION

"To produce young Engineers of caliber, who would be committed to their profession with ethics, will be able to contribute to Civil Engineering and allied fields through research and innovation and optimizing usage of resources globally making the world more eco-friendly to live in."

MISSION

- To make the Department centre of excellence for training the undergraduate students.
- To promote involvement of staff and students in research and advanced training.
- To develop good understanding skills in student communities about Civil Engineering, ethical practices, automation design and society need centric teaching and learning and imparting value addition skills.
- To provide student-centric learning environment through innovative pedagogy and education reforms

BoS

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Program Overview

Civil Engineering primarily deals with planning, design, construction, and operation of infrastructural facilities essential to modern life, ranging from transit systems to offshore structures to space satellites. Major disciplines within Civil Engineering that are closely interrelated are structural, environmental, geotechnical, water resources, transportation, construction and urban planning.

Transportation Engineering is one of the major branches of Civil Engineering and it involves planning, design, construction, operation and maintenance of transportation facilities. The facilities support air, highway, railroad, pipeline, water, and even space transportation. Transportation Engineering includes sizing of transportation facilities, selection of materials and design of pavement and geometry of roadway.

In Transportation Engineering, students acquire advanced know-how concerning the planning, design, operations, performance, evaluation, maintenance and rehabilitation of transportation systems including their economics and social aspects. This field imbibes in each student analytic, problem-solving and management skills suitable for public and private sector professional works. Students are trained on the application of various software and programming skills for simulation of traffic flow and Artificial Inteligence (AI), Internet of Things (IoT) and Intelligent Transportation System (ITS) applications to address urban transportation issues. The challenges faced in Transportation Engineering are developing network links and major terminals to satisfy transportation demands, with due regard for the resultant land-use, environmental and other impacts of these facilities.

The School of Civil Engineering at REVA UNIVERSITY offers M. Tech. in Transportation Engineering and Management –a postgraduate program to create motivated, innovative, creative and thinking graduates to fill the roles of Transportation Engineers and managers who can conceptualize, design, analyze, develop and manage transportation systems to meet the modern-day requirements.

Both public and private sectors across the globe are investing significantly in road development, airport construction, high-speed railways, metro rail, bridges, waterways and many such infrastructure projects necessitating the need for Transportation Engineers.In this context, the School of Civil Engineering at REVA UNIVERSITY would like to add to the growing human resources needs of the infrastructure sector as transportation designers and managers through its M. Tech. program in Transportation Engineering and Management.

M.Tech. programme in Transportation Engineering and Management has been structured to provide an in-depth knowledge to students of School of Civil Engineering in various subjects like Traffic Engineering, Urban Transport Plannin, Pavement Materials, Analysis and Design, Transportation Data Analysis, Railways, Airways and Harbour Engineering, Artificial Intelligence in Transportation Engineering, Applied Traffic Engineering,

Pavement Evaluation & Management System. The specialized soft core courses like IoT applications in Transportation, Intelligent Transportation Systems, Geometric Design of Highways, Road Safety and Management, GIS applications in Transportation Engineering, Land use and Transportation planning, Highway Economics and Finance and Environmental Impact of Transportation being offered will help students to specialize in different areas of their interest and industry needs.

Program Educational Objectives (PEO's)

After few years of post-graduation, the graduates of M.Tech CE (Transportation Engineering and Management) will be

PEO-1	Have successful professional careers in industry, government, academia and military as innovative engineers
PEO-2	Successfully solve engineering problems associated with the lifecycle of Civil Engineering system, in particular transportation engineering by communicating effectively either leading a team or as a team member with ethical practices.
PEO-3	Continue to learn and advance their careers through activities such as research and development, acquiring doctoral degree, participation in national level research programmes, teaching and research at university level etc.,
PEO-4	Active members ready to serve the society locally and internationally, may take up entrepreneurship for the growth of economy and to generate employment; and adopt the philosophy of lifelong learning to be aligned with economic and technological development.

Program Outcomes (POs)

On successful completion of the program, the graduates M.Tech CE (Transportation Engineering and Management) program will be able to:

PO1. **Demonstrate in-depth knowledge** of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

PO2. **Analyze complex engineering problems critically**, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

PO3. **Think laterally and originally, conceptualize and solve engineering problems, evaluate** a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

PO4. **Extract information pertinent to unfamiliar problems through literature survey and experiments**, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

PO5. **Create, select, learn and apply appropriate techniques**, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.

PO6. **Possess knowledge and understanding of group dynamics, recognize** opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

PO7**. Demonstrate knowledge and understanding** of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

PO8. **Communicate with the engineering community, and with society at large**, regarding **complex engineering activities** confidently and effectively, such as, being able to comprehend and write effective

reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

PO9: **Recognize the need for**, and have the preparation and ability to engage in **life-long learning** independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

PO10. **Acquire professional and intellectual integrity,** professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

PO11. **Observe and examine critically the outcomes** of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback (**SELF learning**)

Programme Specific Outcomes (PSO's)

On successful completion of the program, the graduates of M.Tech CE (Transportation Engineering and Management) program will be able to :

PSO-1: Apply knowledge of Transportation Engineering and management in real time.

PSO-2: Analyse a system, component or process in the knowledge areas of Transportation Engineering in real time problems.

PSO-3: Design a system, component, or process in more than one areas of Transportation Engineering.

PSO-4: Conduct investigations and address complex Transportation engineering problems; Utilize and develop innovative tools and techniques that are appropriate in Transportation Engineering discipline.

Regulations – M Tech., Degree Program
Academic Year 2020-21 Batch

(Framed as per the provisions under Section 35 (ii), Section 7 (x) and Section 8 (xvi) & (xxi) of the REVA University Act, 2012)

1. Title and Commencement:

1.1 These Regulations shall be called **"REVA University Academic Regulations – M Tech., Degree Program 2020-21 Batch subject to amendments from time to time by the Academic Council on recommendation of respective Board of Studies and approval of Board of Management**

1.2 These Regulations shall come into force from the date of assent of the Chancellor.

2. The Programs:

These regulations cover the following M Tech., Degree programs of REVA University offered during 2020-21

M Tech (Full Time) in:
Artificial Intelligence
Computer Science and Engineering
Computer Aided Structural Engineering
Construction Technology & Management
Digital Communication and Networking
Machine Design
Power Energy & Systems
Transportation Engineering and Management
VLSI and Embedded Systems

Also
M Tech (Part Time) in:
Computer Science and Engineering
VLSI and Embedded Systems

3. Duration and Medium of Instructions:

3.1 **Duration:** The duration of the M Tech degree program shall be **TWO years** comprising of **FOUR** Semesters. A candidate can avail a maximum of 8 semesters - 4 years as per double duration norm, in

one stretch to complete M Tech degree. The duration for part time students is **THREE years** and a maximum of 6 years they are required to complete the program.

3.2 The medium of instruction shall be English.

4. Definitions:

4.1 Course: "Course" means a subject, either theory or practical or both, listed under a programme; Example: "Finite Element Method of Analysis" in M Tech Civil Engineering program, "Advanced Theory of Vibration" in M Tech., Mechanical program are examples of courses to be studied under respective programs.

Every course offered will have three components associated with the teaching-learning process of the course, namely:

L	**Lecture**
T	**Tutorial**
P	**Practice**

Where:

L stands for **Lecture** session consisting of classroom instruction.

T stands for **Tutorial** session consisting participatory discussion / self-study/ desk work/ brief seminar presentations by students and such other novel methods that make a student to absorb and assimilate more effectively the contents delivered in the Lecture classes.

P stands for **Practice** session and it consists of Hands on Experience / Laboratory Experiments / Field Studies / Case Studies / Project Based Learning or Course end Project/Self Study/ Online courses from listed portals that equip students to acquire the much required skill component.

4.2 Classification of Courses

Courses offered are classified as: Core Courses, Open Elective Courses, Project work/Dissertation

4.2.1 **Core Course:** A course which should compulsorily be studied by a candidate choosing a particular program of study

4.2.2 **Foundation Course:** The foundation Course is a mandatory course which should be completed successfully as a part of graduate degree program irrespective of the program of study

4.2.3 **Hard Core Course (HC) simply core course:** The **Hard Core Course** is a Core Course in the main branch of study and related branch(es) of study, if any, that the candidates have to complete compulsorily

4.2.4 **Soft Core Course (SC) (also known as Professional Elective Course)**

A Core course may be a **Soft Core** if there is a choice or an option for the candidate to choose a course from a pool of courses from the main branch of study or from a sister/related branch of study which supports the main branch of study

4.2.5 **Open Elective Course (OE):**

An elective course chosen generally from other discipline / subject, with an intention to seek exposure to the basics of subjects other than the main discipline the student is studying is called an **Open Elective Course**

4.2.6 **Project Work / Dissertation:**

Project work / Dissertation work is a special course involving application of knowledge in solving / analysing /exploring a real life situation / difficult problems to solve a multivariable or complex engineering problems.

5. Eligibility for Admission:

5.1. The eligibility criteria for admission to M Tech Program (Full Time) of 2 years (4 Semesters) and (Part Time) of 3 years (6 Semesters) are given below:

Sl. No.	Program	Duration	Eligibility
1	Masters of Technology (M Tech) in Artificial Intelligence	4 Semesters (2 years)	B E / B.Tech. in CSE / ISE / TE / MCA / M. Sc. in Computer Science or Mathematics or Information Science or Information Technology with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University / Institution or AMIE or any other qualification recognized as equivalent there to.
2	M Tech in Computer Science and Engineering	**Full Time** – 4 Semesters (2 years) **Part Time** – 6 Semesters (3 years)	B E / B.Tech. in ECE / IT / EEE / CSE / ISE / TE / MCA / M.Sc. in Computer Science or Mathematics or Information Science or Information Technology with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University / Institution or AMIE or any other qualification recognized as equivalent there to.

3	M Tech in Computer Aided Structural Engineering Construction Technology & Management Transportation Engineering and Management	4 Semesters (2 years)	BE/ B.Tech. in Civil Engineering with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University / Institution or AMIE or any other qualification recognized as equivalent there to.
4	M Tech in Power Energy & Systems	4 Semesters (2 years)	BE/ B.Tech. in EE/ EEE/ ECE/ CSE/ MS / M.Sc. in Mathematics/Physics/Electronics / Information Technology or Information Science with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University / Institution or AMIE or any other qualification recognized as equivalent there to.
5	M Tech in Digital Communication and Networking Machine Design	4 Semesters (2 years)	B E / B.Tech. in ECE /TE / EEE / CSE / ISE / Instrumentation Technology / Medical Electronics/M Sc in Electronics with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University/Institution or AMIE or any other qualification recognized as equivalent there to.
6	M Tech in VLSI and Embedded Systems	**Full Time** – 4 Semesters (2 years) **Part Time** – 6 Semesters (3 years)	B E / B.Tech. in ECE /TE / EEE / CSE / ISE / Instrumentation Technology / Medical Electronics/M Sc in Electronics with a minimum of 50% (45% in case of SC/ST) marks in aggregate of any recognized University/Institution or AMIE or any other qualification recognized as equivalent there to.
7	M Tech in Machine Design	4 Semesters (2 years)	BE / B.Tech. in Mechanical/Aeronautical / Automobile / Industrial Production Engineering with a minimum of 50% (45% in case of candidate belonging to SC/ST category) marks in aggregate, of any recognized University / Institution or AMIE or any other qualification recognized as equivalent there to.

5.2 Provided further that the eligibility criteria are subject to revision by the Government Statutory Bodies, such as AICTE, UGC from time to time.

6. Courses of Study and Credits

6.1 Each course of study is assigned with certain credit value

6.2 Each semester is for a total duration of 20 weeks out of which 16 weeks dedicated for teaching and learning and the remaining 4 weeks for final examination, evaluation and announcement of results

6.3 The credit hours defined as below

In terms of credits, every one hour session of L amounts to 1 credit per Semester and a minimum of two hour session of T or P amounts to 1 credit per Semester or a three hour session of T / P amounts to 2 credits over a period of one Semester of 16 weeks for teaching-learning process.

1 credit = 13 credit hours spread over 16 weeks or spread over the semester

The total duration of a semester is 20 weeks inclusive of semester-end examination.

The following table describes credit pattern

Table -2: Credit Pattern

Lectures (L)	Tutorials (T)	Practice (P)	Credits (L:T:P)	Total Credits	Total Contact Hours
4	2	0	4:1:0	5	6
3	2	0	3:1:0	4	5
3	0	2	3:0:1	4	5
2	2	2	2:1:1	4	6
0	0	6	0:0:3	3	6
4	0	0	4:0:0	4	4
2	0	0	2:0:0	2	2

a. The concerned BoS will choose the convenient Credit Pattern for every course based on size and nature of the course

7. Different C**ourses of Study**:

Different C**ourses of Study** are labeled as follows:

a. Core Course (CC)
b. Foundation Course (FC)
c. Hard Core Course (HC)
d. Soft Core Course (SC)
e. Open Elective Course (OE)
f. Minor Project
g. Major Project / Dissertation:

The credits for minor projects, major project/Dissertation will be decided by the respective Schools.

8. Credit and Credit Distributions:

8.1 A candidate has to earn 72 credits for successful completion of M Tech degree with a distribution of credits for different courses as prescribed by the University.

8.2 A candidate can enroll for a maximum of 24 credits per Semester. However s/he may not successfully earn a maximum of 24 credits per semester. This maximum of 24 credits does not include the credits of courses carried forward by a candidate.

8.3 **Only such full time candidates who register for a minimum prescribed number of credits in each semester from I semester to IV semester and complete successfully 72 credits in 4 successive semesters shall be considered for declaration of Ranks, Medals, Prizes and are eligible to apply for Student Fellowship, Scholarship, Free ships, and such other rewards / advantages which could be applicable for all full time students and for hostel facilities**.

9. Assessment and Evaluation

9.1 The assessment and evaluation process happens in a continuous mode. However, for reporting purpose, a Semester is divided into 3 components as IA1, IA2 and SEE. The performance of a candidate in a course will be assessed for a maximum of 100 marks as explained below.

(i) Component IA1:

The first Component (IA1), of assessment is for 25 marks. This will be based on test, assignment / seminar. During the first half of the semester (i.e. by 8th week), the first 50% of the syllabus (Unit 1&2) will be completed. This shall be consolidated during the first three days of 8th week of the semester. A review test based on IA1 will be conducted and completed in the beginning of the 9th week. In case of courses where test cannot be conducted, the form of assessment will be decided by the concerned school and such formalities of assessment will be completed in the beginning of the 9th week. The academic sessions will continue for IA2 immediately after completion of process of IA1.

The finer split - up for the award of marks in IA1 is as follows:

Assignment & Seminars…….. 10 marks for the first 20% of the syllabus

Test (Mid-Term)……..15 marks for the first 30% of the syllabus

Total……..25 marks

(ii) Component IA2:

The second component (IA2), of assessment is for 25 marks. This will be based on test, assignment /seminar. The continuous assessment and scores of second half of the semester (9th to 16th week) will be consolidated during 16th week of the semester. During the second half of the semester the remaining units in the course will be completed. A review test based on IA2 will be conducted and completed during 16th week of the semester. In case of courses where test cannot be conducted, the form of assessment will be decided by the

concerned school and such formalities of assessment will be completed during 16th week.

The 17th week will be for revision of syllabus and preparation for the semester – end examination.

The finer split - up for the award of marks in IA2 is as follows:

Assignment/Seminar……..10 marks for the second 20% of the syllabus

Review Test (Mid-Term) ……15 marks for the second 30% of the syllabus

Total……..25 marks

(iii) Component SEE:

The Semester End Examination of 3 hours duration for each course shall be conducted during the 18th & 19th week. **This forms the third / final component of assessment (SEE) and the maximum marks for the final component will be 50.**

9.2 The schedule of continuous assessment and examinations are summarized in the following Table below.

Component	Period	Syllabus	Weightage	Activity
IA1	1st Week to 8th Week	First 50% (two units)		Instructional process and Continuous Assessment
	Last 3 days of 8th Week		25%	Consolidation of IA1
IA2	9th week to 16th week	Second 50% (remaining two units)		Instructional process and Continuous Assessment
	Last 3 days of 16th week		25%	Consolidation of IA2
SEE	17th and 18th week			Revision and preparation for Semester end examination
	19th week to 20th week	Entire syllabus	50%	Conduct of semester end examination and Evaluation concurrently
	21st week			Notification of Final Grades
***Evaluation shall begin very first day after completion of the conduct of examination of the first course and both examination and evaluation shall continue concurrently. The examination results / final grades be announced latest by 21st week**				

Note:

1. Practical examination wherever applicable shall be conducted before conducting of IA2 examination. The calendar of practical examination shall be decided by the respective school.
2. Finally**, awarding the Grades** is announced latest by 5 days after completion of the examination.

9.3 The Assessment of MOOC and Online Courses shall be decided by the concerned School Board of

Studies (BOS).

9.3.1 **For > 3 credit courses**

i	IA-I	25 marks
ii	IA-2	25 marks
iii	Semester end examination by the concern school board (demo, test, viva voice etc)	50 marks
	Total	**100 marks**

9.3.2 **For 1 & 2 credit courses**

i	IA-I	15 marks
ii	IA-2	15 marks
iii	Semester end examination by the concern school board (demo, test, viva voice etc)	20 marks
	Total	**50 marks**

9.3.3 The 50 marks meant for Internal Assessment (IA) of the performance in carrying out practical shall further be allocated as under:

i	Conduction of regular practical / experiments throughout the semester	20 marks
ii	Maintenance of lab records / Activities /Models / charts etc	10 marks
iii	Performance of mid-term test (to be conducted while conducting second test for theory courses); the performance assessments of the mid-term test includes performance in the conduction of experiment and write up about the experiment.	20 marks
	Total	**50 marks**

In case of an integrated course 20% marks be earmarked for laboratory work.

For example:

During IA1

Laboratory work ……..10 marks

Test (Mid-Term)……15 marks for the first 50% of the theory syllabus

Total…….25 marks

During IA2

Laboratory work…….. 10 marks

Test (Mid-Term)……..15 marks for the second 50% of theory syllabus

Total……25 marks

SEE to be conducted for theory portions only and assessed for 50 marks

10. Setting Questions Papers and Evaluation of Answer Scripts:

10.1 There shall be three sets of questions papers set for each course. Two sets of question papers shall be set by the internal and one set by external examiner for a course. The Chairperson of the BoE shall get the question papers set by internal and external examiners.

10.2 The Board of Examiners shall scrutinize and approve the question papers and scheme of valuation.

10.3 There shall be double evaluation, viz, first valuation by the internal evaluator who has taught the course and second evaluation shall be an external examiner who is familiar with the course. The average marks of the two evaluations (internal examiner & external examiner) shall be the marks to be considered for declaration of results.

10.4 The examination for Practical work/ Field work/Project work will be conducted jointly by two examiners (internal and external). However, in case of non-availability of external examiner or vice versa, the Chairperson BoE at his discretion can invite internal / external examiners as the case may be, if required.

10.5 If a course is fully of (L=0):T: (P=0) type, then the examination for SEE Component will be as decided by the BoS concerned.

10.6 In case of a course with only practical component a practical examination will be conducted with two examiners and each candidate will be assessed on the basis of: a) Knowledge of relevant processes, b) Skills and operations involved, and c) Results / Products including calculation and reporting.

10.7 The duration for Semester-End practical examination shall be decided by the Controller of Examinations.

11. **Evaluation of Minor Project / Major Project / Dissertation:**

Right from the initial stage of defining the problem, the candidate has to submit the progress reports periodically and also present his/her progress in the form of seminars in addition to the regular discussion with the supervisor. At the end of the semester, the candidate has to submit final report of the project / dissertation, as the case may be, for final evaluation. The components of evaluation are as follows:

Component – I	(IA1)	Periodic Progress and Progress Reports (25%)
Component – II	(IA2)	Results of Work and Draft Report (25%)
Component– III	(SEE)	Final Evaluation and Viva-Voce (50%). Evaluation of the report is for 30% and the Viva-Voce examination is for 20%.

12. All assessments must be done by the respective Schools as per the guidelines issued by the Controller of

Examinations. However, the responsibility of announcing final examination results and issuing official transcripts to the students lies with the office of the Controller of Examinations.

13. Requirements to Pass a Course

13.1 A candidate's performance from all 3 components will be in terms of scores, and the sum of all three scores will be for a maximum of 100 marks (25 + 25 + 50). A candidate who secures a minimum of 40% in the SEE and an overall 40% (IA1+IA2+SEE) in a course is said to be successful.

13.2 **The Grade and the Grade Point:** The Grade and the Grade Point earned by the candidate in the subject will be as given below:

Marks, P	Grade, G	Grade Point (GP=V x G)	Letter Grade
90-100	10	v*10	O
80-89	9	v*9	A+
70-79	8	v*8	A
60-69	7	v*7	B+
55-59	6	v*6	B
50-54	5.5	v*5.5	C+
40-49	5	v*5	C
0-39	0	v*0	F
ABSENT			AB

O - Outstanding; A+-Excellent; A-Very Good; B+-Good; B-Above Average; C+-Average; C-Satisfactory; F – Unsatisfactory.

Here, P is the percentage of marks (P=[(IA1+IA2)+SEE] secured by a candidate in a course which is **rounded to nearest integer**. v is the credit value of course. G is the grade and GP is the grade point.

a. Computation of SGPA and CGPA

The Following procedure to compute the Semester Grade Point Average (SGPA)

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

SGPA (Si) = ∑(Ci x Gi) / ∑Ci

Where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

b. Illustration for Computation of SGPA and CGPA

Illustration No. 1

Course	Credit	Grade letter	Grade Point	Credit Point (Credit x Grade)
Course 1	**3**	**A**	**9**	**3X9=27**
Course 2	**3**	**B**	**8**	**3X8=24**
Course 3	**3**	**C**	**7**	**3X7=21**
Course 4	**3**	**O**	**10**	**3X10=30**
Course 5	**3**	**D**	**6**	**3X6=18**
Course 6	**3**	**O**	**10**	**3X10=30**
Course 7	**2**	**A**	**9**	**2X 9 = 18**
Course 8	**2**	**B**	**8**	**2X 8 = 16**
	22			**184**

Thus, **SGPA = 184 ÷ 22 = 8.36**

c. Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (72) for two year post graduate degree in a specialization is calculated taking into account all the courses undergone by a student over all the semesters of a program, i. e **CGPA = ∑(Ci x Si) / ∑Ci**

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Illustration:

CGPA after Final Semester

Semester (ith)	No. of Credits (Ci)	SGPA (Si)	Credits x SGPA (Ci X Si)
1	22	8.36	22 x 8.36 = 183.92
2	22	8.54	22 x 8.54 =187.88
3	16	9.35	16x9.35=149.6
4	12	9.50	12x9.50=114
Cumulative	**72**		635.4

Thus, **CGPA** = $\frac{22x8.36+22x8.54+16x9.35+12x9.50}{72}$ = 8.83

13.3 **Conversion of Grades into Percentage:**

Conversion formula for the conversion of CGPA into Percentage is:

Percentage of marks scored = CGPA Earned x 10

Illustration: CGPA Earned 8.83 x 10=88.30

14. Classification of Results

The final grade point (FGP) to be awarded to the student is based on CGPA secured by the candidate and is given as follows:

CGPA	Grade (Numerical Index)	Letter Grade	Performance	FGP
	G			Qualitative Index
9 >= CGPA 10	10	O	Outstanding	Distinction
8 >= CGPA < 9	9	A+	Excellent	
7 >= CGPA < 8	8	A	Very Good	First Class
6 >= CGPA < 7	7	B+	Good	
5.5> = CGPA < 6	6	B	Above average	Second Class
> 5 CGPA < 5.5	5.5	C+	Average	
> 4 CGPA <5	5	C	Satisfactory	Pass
< 4 CGPA	0	F	Unsatisfactory	Unsuccessful

Overall percentage=10*CGPA

a. **Provisional Grade Card:** The tentative / provisional Grade Card will be issued by the Controller of Examinations at the end of every Semester indicating the courses completed successfully. The provisional grade card provides **Semester Grade Point Average** (SGPA).This statement will not contain the list of DROPPED courses.

b. **Final Grade Card:** Upon successful completion of the Post Graduate Degree a Final Grade card consisting of grades of all courses successfully completed by the Candidate will be issued by the COE.

15. Attendance Requirement:

15.1 All students must attend every lecture, tutorial and practical classes.

15.2 In case a student is on approved leave of absence (e g:- representing the University in sports, games or athletics, placement activities, NCC, NSS activities and such others) and / or any other such contingencies like medical emergencies, the attendance requirement shall be minimum of 75% of the classes taught.

15.3 Any student with less than 75% of attendance in aggregate of all the courses including practical courses / field visits etc., during a semester shall not be permitted to appear to the end semester examination and such student shall seek re-admission

16. Re-Registration and Re-Admission:

16.1 In case a candidate's class attendance in aggregate of all courses in a semester is less than 75% or as stipulated by the University, such a candidate is considered as dropped the semester and is not allowed to appear for semester end examination and he / she shall have to seek re-admission to that semester during

subsequent semester / year within a stipulated period.

16.2 In such case where in a candidate drops all the courses in a semester due to personal reasons, it is considered that the candidate has dropped the semester and he / she shall seek re-admission to such dropped semester.

17. **Absence during Internal Test:**

In case a student has been absent from an internal tests due to the illness or other contingencies he / she may give a request along with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Director of the School, for conducting a separate internal test. The Director of the School may consider such request depending on the merit of the case and after consultation with course instructor and class teacher, and arrange to conduct a special internal test for such candidate(s) well in advance before the Semester End Examination of that respective semester. Under no circumstances internal tests shall be held / assignments are accepted after Semester End Examination.

18. **Eligibility to Appear for Semester End Examination (SEE)**

18.1 Only those students who fulfill 75% attendance requirement and who secure minimum 30% marks in IA1 and IA2 together in a course are eligible to appear for SEE examination in that course.

18.2 Those students who have 75% of attendance but have secured less than 30% marks in IA1 and IA2 together in a course are not eligible to appear for SEE examination in that course. They are treated as dropped the course and they will have to repeat that course whenever it is offered.

18.3 In case a candidate secures more than 30% in IA1 and IA2 together but less than 40% in aggregate of IA1, IA2 and SEE in a course is considered as unsuccessful and such a candidate may either opt to DROP that course or appear for SEE examination during the subsequent semesters / years within the stipulated period.

18.4 In such a case wherein he / she opts to appear for just SEE examination, then the marks secured in IA1 and IA2 shall get continued. Repeat SEE examination will be conducted in respective semesters.

19. **Provision for Supplementary Examination**

In case a candidate fails to secure a minimum of 40% (20 marks) in Semester End Examination (SEE) and a minimum of 40% marks overall (IA and SEE together), such candidate shall seek supplementary examination of only such course(s) wherein his / her performance is declared unsuccessful. The supplementary

examinations are conducted after the announcement of even semester examination results. The candidate who is unsuccessful in a given course(s) shall appear for supplementary examination of odd and even semester course(s) to seek for improvement of the performance.

20. **Provision to Carry Forward the Failed Subjects / Courses:**

A candidate who secures a minimum of 40% in the SEE and an overall 40% (IA1+IA2+SEE) in a course is said to be successful otherwise considered that the candidate has failed the course. A candidate is required to successfully complete all the courses before submission of major project report or dissertation report.

(It means that the candidate has no restrictions on the number of courses that can be carried forward)

21. **Provision for Appeal**

If a candidate is not satisfied with the evaluation of Internal Assessment components (Internal Tests and Assignments), he/she can approach the Grievance Cell with the written submission together with all facts, the assignments, and test papers, which were evaluated. He/she can do so before the commencement of respective semester-end examination. The Grievance Cell is empowered to revise the marks if the case is genuine and is also empowered to levy penalty as prescribed by the University on the candidate if his/her submission is found to be baseless and unduly motivated. This Cell may recommend for taking disciplinary/corrective action on an evaluator if he/she is found guilty. The decision taken by the Grievance committee is final.

22. **Grievance Committee:**

In case of students having any grievances regarding the conduct of examination, evaluation and announcement of results, such students can approach Grievance Committee for redressal of grievances. Grievance committees will be formed by CoE in consultation with VC

For every program there will be one grievance committee. The composition of the grievance committee is as follows:-

- The Controller of Examinations - Ex-officio Chairman / Convener
- One Senior Faculty Member (other than those concerned with the evaluation of the course concerned) drawn from the school / department/discipline and/or from the sister schools / departments/sister disciplines – Member.
- One Senior Faculty Members / Subject Experts drawn from outside the University school / department – Member.

23. With regard to any specific case of ambiguity and unsolved problem, the decision of the Vice-Chancellor shall be final.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	P02	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TK0101	CO1	3		3									2	2	1
	CO2	2	3	3									1	2	2
	CO3	3	3	3									3	2	1
	CO4	3	3	3		2				2	2		3	2	2
	CO5	2	3		2	2	2			2	2	2	2	3	2
	CO6	2	3	2	1		2			1	2	3	2	1	2
M20TK0102	CO1	1	3	3	2			2		2		2	2		3
	CO2	1	3	3	2			2		2		2	2		3
	CO3	1	3	3	2			2		2		2	2		3
	CO4	1	3	3	2			2		2		2	2		3
	CO5	1	3	3	2			2		2		2	2		3
	CO6	1	3	3	2			2		2		2	2		3
M20TK0103	CO1	3	2	2		2	3			3	2	2	3	2	1
	CO2	2	3	2		2	2				2		3	3	1
	CO3	3	2	2	1	1	2	2	3		2		3	2	2
	CO4	3	2	2	2	2		2		3	2	2	3	3	2
	CO5	2	3	2	2	1		2		2	3	2	3	2	2
	CO6	3	2	3	2		3	3	3		2	2	3	3	2
M20TK0104	CO1	3	2	3	3	3	3						3		1
	CO2	3	2	1	3		3						3	2	2
	CO3	3	3	3	3	2	2					3	3	3	1
	CO4	3	2		3		3					2	3	2	2
	CO5	2	3	3	3	2		1					3	3	2
	CO6	3	2	2	3		3					2	3	2	2
M20TK0105	CO1	3		3	3	3	3						3		1
	CO2	2	3	2	3		2					3	3	2	1
	CO3	3	3	3	3		2					3	3	3	1
	CO4	2	3	2	3		2					3	3	3	2
	CO5	3	2		3		3						3	2	2
	CO6	2	3	3	3	2		1					3	3	2
M20TK0106	CO1	2	2		2	3		2					1	2	1
	CO2	2	2		2	3		2				3	1	1	2
	CO3	2				2		3					1	2	1
	CO4	2	3	2		3		3				2	1	2	2
	CO5	2	2		2	1		2				3	2	1	2
	CO6	2	3	2		3		3				2	1	2	2
M20TK0107	CO1	3	2	2		2	3			3	2	2	3	2	1
	CO2	3	2	2	2	2		2		3	2	2	3	3	2

	CO3	3	2	2	1	1	2	2	3		2		3	2	2
	CO4	3	2	2	2	2		2		3	2	2	3	3	2
	CO5	3	2	3	2		3	3	3		2	2	3	3	2
	CO6	3	2	2	2	2		2		3	2	2	3	3	2
M20TK0108	CO1	2	2	3	3	3			2		3	3	3	2	1
	CO2					3			3	3	3	1	2	2	2
	CO3	3	3	2		2	2	3			2	3	2	2	3
	CO4		2				3	2	2	2	3		2	2	3
	CO5	3	2	3		3	3	3	2	3	2		2	2	2
	CO6	2	3	2		3	2	2	2	3	3	3	2	2	2
M20TK0201	CO1	3	3	2		3			3				3	2	1
	CO2		3	3		3						3	3	3	1
	CO3	3	2	3	3		3						3	2	2
	CO4	2	3	3	3	2	3						3	3	2
	CO5	3	1	2	1	2	1					3	2	1	2
	CO6	2	3	3	3	2	3						3	3	2
M20TK0202	CO1	3	3	2									2	2	1
	CO2	2	3	3	3	2		1					3	3	2
	CO3	3	3	2		2			1				2	2	1
	CO4	3	3							3			3	2	2
	CO5	3	3	2	3				1	3		3	3	2	2
	CO6		2		3			1		2			3		2
M20TKS211	CO1	3		3									2	2	1
	CO2	2		3									2	2	1
	CO3	3	3	3									3	2	1
	CO4	3	3	2									3	3	2
	CO5	3	3	3		2				2	2		3	2	2
	CO6		3		2	2	2			2	2	2	2	3	2
M20TKS212	CO1	3		3									2	2	1
	CO2	3	3	3									3	2	1
	CO3	3	3	3		2				2	2		3	2	2
	CO4	2	3		2	2	2			2	2	2	2	3	2
	CO5	2	3	1	2		2			2	2	2	2	3	2
	CO6		3		2	2	2			2	2	2	2	3	2
M20TKS221	CO1	3	3	3		2	2	3	3		3		3	2	2
	CO2	3	2	2	1	3	2	3	2		3		2	3	2
	CO3	3	3	3	1	3	1	3	3		3		3	3	2
	CO4	3	2	3	2	3	1	3	2		3		3	3	2
	CO5	3	3	3	1	3	1	3	3		3		3	3	2
	CO6	3	2	3	2				3		2		3	2	1
M20TKS222	CO1	2		3	2	3	1	1			2	3	3	3	
	CO2														
	CO3	2	2	2	3	3				3	2		3	3	

	CO4	3	2		2	3	3	2		2	3		3	2	1
	CO5	2	3		3	2	2		1		3		3	2	1
	CO6	2	2		2	3	2	2	1		2		2	2	1
M20TKS231	CO1	3		3									2	2	1
	CO2	3	3	3									3	2	1
	CO3	3	3	3		2				2	2		3	2	2
	CO4		3		2	2	2			2	2	2	2	3	2
	CO5	3	3	3									3	2	1
	CO6	3	3	3		2				2	2		3	2	2
M20TKS232	CO1	2	2		2	3		2					1	2	1
	CO2	2	2		2	3		2				3	1	1	2
	CO3	2				2		3					1	2	1
	CO4	2	3	2		3		3				2	1	2	2
	CO5	2	3	2		3		3				2	1	2	2
	CO6	3	1			2		2					1	2	2
M20TKS241	CO1			3			2	2	1	1			3		1
	CO2	3		3		2	1		3	2		2	3	2	2
	CO3	3		3	3	2	1			3			3	2	2
	CO4	3		3	3	3		2	3				3		3
	CO5	3		3	3	3		2	3				3		3
	CO6	3		3	2	2	1		3	3	3		3	2	3
M20TKS242	CO1			3		2				2		2	3	3	1
	CO2	3	3	2		2	2	1		2	2	3	3	3	1
	CO3	2	2	3	3		2				3	3	3	2	2
	CO4		3		2	1		2	1		3	2	3	2	2
	CO5		3		2	1		2	1		3	2	3	2	2
	CO6	2	3	2		3		3				2	1	2	2
M20TK0203	CO1	3	3	2	3		2	2	1	1			3	3	2
	CO2	3	2	3	3	2	1		3	2		2	3	3	1
	CO3	3	3	3	3	2	1			3			3	3	2
	CO4	3	2	3	3	3		2	3				3	3	2
	CO5	3	2	3	3	2	1	2	2	2			3	2	2
	CO6	3	2	2	2	3	2	1		3			3	2	3
M20TK0204	CO1	2	2	3	3	3			2		3	3	3	2	1
	CO2	2	1	2		3			3	3	3	1	2	2	2
	CO3	3	3	2	2	2	2	3			2	3	2	2	3
	CO4	1	2		2		3	2	2	2	3		2	2	3
	CO5	2	3	3		3	3		2	2	2	3	2	2	2
	CO6	1	2	2	2	3	2	3	3	2	2	3	2	2	2

Mapping of PEO'S with Respect to PO'S

	PO1	PO2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3	PSO4
PEO1	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO2	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO3	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO4	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

REVA UNIVERSITY
Bengaluru, India

M. Tech. (TRANSPORTATION ENGINEERING AND MANAGEMENT)

Programme Scheme of Instructions

(Effective from Academic Year 2020)

Scheme of Instructions 2020-22

I SEMESTER

Sl. No	Course Code	Title of the Course	HC/SC/OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours
					L	T	P	Total	
1	M20TK0101	Artificial Intelligence in Transportation Engineering	HC	B.E/ B. Tech Civil Engineering	2	1	-	3	4
2	M20TK0102	Pavement Materials, Analysis and Design	HC		2	1	-	3	4
3	M20TK0103	Railways, Airways and Harbour Engineering	HC		2	1	-	3	4
4	M20TK0104	Traffic Engineering	HC		2	1	-	3	4
5	M20TK0105	Transportation Data Analysis	HC		2	1	-	3	4
6	M20TK0106	Urban Transport Planning	HC		2	1	-	3	4
7	M20TK0108	Mini Project-I	Practical		0	0	2	2	2
TOTAL								**20**	**26**
Practical									
8	M20TK0107	Traffic & Pavement Engineering laboratory	Practical/ HC		-	-	2	2	3
TOTAL								**02**	**03**
TOTAL SEMESTER CREDITS								**22**	
TOTAL CUMULATIVE CREDITS								**22**	
TOTAL CONTACT HOURS								**29**	

II SEMESTER

Sl. No	Course Code	Title of the Course	HC/SC/OE	Pre requisite	Credit Pattern & Credit Value				Contact Hours
					L	T	P	Total	
1	M20TK0201	Applied Traffic Engineering	HC	B.E/ B. Tech Civil Engineering	2	1	-	3	4
2	M20TK0202	Pavement Evaluation & Management System	HC		2	1	-	3	4
3	M20TKS211	Intelligent Transportation Systems	SC		2	1	-	3	4
	M20TKS212	IoT applications in Transportation			2	1	-	3	4
4	M20TKS221	Geometric Design of Highways	SC		2	1	-	3	4
	M20TKS222	Road Safety and Management			2	1	-	3	4
5	M20TKS231	GIS applications in Transportation Engineering	SC		2	1	-	3	4
	M20TKS232	Land use and Transportation planning.			2	1	-	3	4
6	M20TKS241	Environmental Impact of Transportation	SC		2	1	-	3	4
	M20TKS242	Highway Economics and Finance			2	1	-	3	4
7	M20TK0204	Mini Project-II	Practical		0	0	2	2	2
TOTAL								**20**	**26**
Practical									
8	M20TK0203	Transportation Software Laboratory	Practical/ HC		-	-	2	2	3
TOTAL								**02**	**03**
TOTAL SEMESTER CREDITS									**22**
TOTAL CUMULATIVE CREDITS									**44**
TOTAL CONTACT HOURS									**29**

III SEMESTER

Sl. No	Course Code	Title of the Course	Practical /Term Work / Sessions	Pre requisite	Credit Pattern & Credit Value				Contact Hours
					L	T	P	Total	
1	M20TKON01	MOOC/SWAYAM Online course	ON	B.E/ B. Tech Civil Engineering	3	1	0	4	--
2	M20TK0301	Internship with Report	Practical/ Term Work and Viva - Voce		2	0	4	6	--
3	M20TK0302	Project Phase-I	Practical/ Report and Viva -Voce		2	0	4	6	--
TOTAL								**16**	
TOTAL SEMESTER CREDITS								**16**	
TOTAL CUMULATIVE CREDITS								**60**	
TOTAL CONTACT HOURS								**--**	

IV SEMESTER

Sl. No	Course Code	Title of the Course	Practical /Team Work / Sessions	Pre requisite	Credit Pattern & Credit Value				Contact Hours
					L	T	P	Total	
1	M20TK0401	Dissertation	Practical/ Thesis Submission and Viva-Voce		2	0	6	8	--
2	M20TK0402	Technical Seminar with Report	Practical/ Term Work		0	0	4	4	--
TOTAL								**12**	
TOTAL SEMESTER CREDITS								**12**	
TOTAL CUMULATIVE CREDITS								**72**	
TOTAL CONTACT HOURS								**-**	

HC = Hard Core: SC= Soft Core: OE = Open Elective

M.Tech. (Transportation Engineering and Management) Programme

DETAILED SYLLABUS

FIRST SEMESTER

Course code	Course Title	Duration		L	T	P	C
M20TK0101	**Artificial Intelligence in Transportation Engineering**	**16 weeks**	**HC**	**2**	**1**	**0**	**3**
Internal assessment: 50 Marks		**Semester End Exam: 50 Marks (Minimum 20 Marks)**					

Course Prerequisite: None

Course Learning Objectives: Student will be able to learn

1. Provides the basic knowledge about Artificial Intelligence Applications in Transportation.
2. Explain the concept of neural networks.
3. Explain the concept of Fuzzy sets theory.
4. Provide an overview of GA applications in Transportation.

Course Outcomes: At the end of the course, the student is expected to be able to

- List of Artificial Intelligence Applications in Transportation
- Identify the Knowledge-Based Systems & Nural networks in Transportation
- Ability to apply ANN to solve the transportation problems.
- Ability to apply Fuzzy set theory to solve the transportation problems.
- Understanding of GA applications.
- Know the guidelines for Application, Improving GA Performance.

Mapping of Course Outcomes with programme Outcomes

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TK0101	CO1	3		3									2	2	1
	CO2	2	3	3									1	2	2
	CO3	3	3	3									3	2	1
	CO4	3	3	3		2				2	2		3	2	2
	CO5	2	3		2	2	2			2	2	2	2	3	2
	CO6	2	3	2	1		2			1	2	3	2	1	2

Weightage distribution for Assessment

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4
CO6		5	3	8	16	Level-5
Total Marks	15	15	20	50	100	
	6th Week	12th Week	14th Week	17th-20th Week		

Course Contents

Unit-1 12 hours

Artificial Intelligence Applications in Transportation: Artificial Intelligence Application Areas, Artificial Intelligence Methods: Knowledge-Based Systems, Neural Networks, Fuzzy Systems and Genetic Algorithms. **Knowledge-Based Systems in Transportation:** The Basic Paradigm: Knowledge, Reasoning, Strengths, Weaknesses, And Guidelines for Application.

Unit-2 12 hours

Neural Networks: Introduction, the Basic Paradigm: Multilayer Perceptron, Advanced Topologies, Neural Network Applications Domain, Strengths and Weaknesses, Guidelines for Network Design.

Unit-3 12 hours

Fuzzy Sets Theory Approach: Introduction, The Nature of Transportation Problems, Void in the Classical Approach, Fuzzy Set Theory and Membership Functions, Application Environments of Fuzzy Sets Theory, Application Problems.

Unit-4 12 hours

Genetic Algorithms: Overview of Genetic Algorithms, Strengths and Weaknesses of GA, Examples of Transportation Problems, Guidelines for Application, Improving GA Performance, Parallel Genetic Algorithms.

Readings and References:

1. Minsky, M. L., and S. Papert. *Perceptrons: An Introduction to Computational Geometry* (First edition). MIT Press, Cambridge, Massachusetts, 1969.
2. Russel, S. J., and P. Norvig. Artificial Intelligence: A Modern Approach. Prentice-Hall, Upper Saddle River, New Jersey, 2002.
3. Feigenbaum, E. A., A. Barr, and P. R. Cohen. *The Handbook of Artificial Intelligence*, Vol. 2, William Kaufman, Inc., 1982.
4. Abdulhai, B., H. Porwal, and W. Recker. Short-Term Freeway Traffic Flow Prediction Using Genetically Optimized Time-Delay-Based Neural Networks. Presented at 78th Annual Meeting of the Transportation Research Board, Washington, D.C., 1999.

5. Ben-Akiva, M., A. de Palma, and I. Kaysi. Dynamic Network Models and Driver Information Systems. *Transportation Research A*, Vol. 25, No. 5, 1991, pp. 251–266.
6. Bellman, R., and L. A. Zadeh. Decision Making in a Fuzzy Environment. *Management Science*, Vol. 17, 1970, pp. 141–164.
7. Berkan, R. C., and S. L. Trubatch. *Fuzzy Systems Design Principles: Building Fuzzy IF_THEN Rule Bases*. IEEE Press, Piscataway, N.J., 1996.
8. Abu-Lebdeh, G., and B. H. Al-Omari. Configuring Micro-Genetic Algorithms for Solving Traffic Control Problems: The Case of Number of Generations. *Proc., 4th International Conference on Uncertainty Modeling and Analysis*, 2003, pp. 70–75.

Course code	Course Title	Duration		L	T	P	C
M20TK0102	**Pavement Materials, Analysis and Design**	**16 weeks**	**HC**	**2**	**1**	**0**	**3**
Internal assessment: 50 Marks	**Semester End Exam: 50 Marks (Minimum 20 Marks)**						

Course Prerequisite: None

Course Learning Objectives: Student will be able to learn

- Understand properties and tests performed on pavement materials.
- Explain the stress analysis in flexible pavements and rigid pavements.
- Provide the factors affecting design and performance of pavements and different terms related to pavement design.
- Learn different design methods for flexible pavement and rigid pavement.

Course Outcomes: At the end of the course, students are expected to be able to

- Characterize the pavement materials and perform tests on pavement materials.
- Evaluate use of new materials for pavement construction and characterization of these materials.
- Analyze the stresses and strains in a flexible and rigid pavement.
- List various factors affecting design and performance of pavements.
- Design a flexible and rigid pavement using IRC, and AASHTO methods.
- Analyze experimental data collected as part of material characterization

Mapping of Course Outcomes with programme Outcomes

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TK0102	CO1	3		3	3	3	3						3		1
	CO2	3	3	3	3		2					3	3	2	1
	CO3		2		3			1		2			3		2
	CO4	3	2		3		3						3	2	1
	CO5	2	3	3	3	2		1					3	3	2
	CO6	1	3	3	2			2		2		2	2		3

Weightage distribution for Assessment

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4
CO6		5	3	8	16	Level-5
Total Marks	15	15	20	50	100	
	6^{th} Week	12^{th} Week	14^{th} Week	17^{th}-20^{th} Week		

Course Contents:

Unit-I 12 hours

Pavement Materials: Materials used in pavement construction; conventional and nonconventional materials; functions, requirements, properties and tests.

Pavement Types and Materials: Types and component parts of pavements; highway and airport pavements; basic characteristics of materials used in pavements.

Unit-II 12 hours

Stresses in Flexible Pavements: Layered system concepts; stress solution for one, two and three layered systems; fundamental design concepts; stress analysis in flexible pavements using KENLAYER. **Stresses in Rigid Pavements:** Westergaard's theory and assumptions; Stresses due to curling, stresses and deflections due to loading, frictional stresses; Stresses in dowel bars and tie bars; Stress analysis in rigid pavements using KENSLABS.

Unit-III 12 hours

Factors Affecting Pavement Design: Variables considered in pavement design; classification of axle types, standard and legal axle loads, tyre pressure, contact pressure, ESWL, EWLF and EAL concepts;

traffic analysis: ADT, AADT, truck factor, growth factor, lane distribution factor, directional distribution factor and vehicle damage factor.

Unit-IV **12 hours**

Design of Flexible Pavements: IRC method of flexible pavement design; AASHTO method of flexible pavement design; design of flexible pavement shoulders. **Design of Rigid Pavements:** IRC method of plain jointed and continuously reinforced rigid pavement design; AASHTO method of rigid pavement design; Design of rigid pavement shoulders.

Readings and References:

1. 1. Asphalt Institute. Thickness Design – Asphalt Pavements for Highways and Streets Manual Series No. 1 (MS-1), Asphalt Institute, Kentucky, USA, 1999.
2. Huang, Y.H. Pavement Analysis and Design, Second Edition, Dorling Kindersley (India) Pvt. Ltd., New Delhi, India, 2008.
3. IRC: 37-2018. Guidelines for the Design of Flexible Pavements, The Indian Roads Congress, New Delhi, India, 2018.
4. IRC: 58-2015 Guidelines for the Design of Plain Jointed Rigid Pavements for Highways, The Indian Roads Congress, New Delhi, India, 2015.
5. Mallick, R.B. and T. El-Korchi Pavement Engineering – Principles and Practice, CRC Press, Taylor and Francis Group, Florida, USA, 2009.
6. Papagiannakis, A.T. and E.A. Masad, Pavement Design and Materials, John Wiley and Sons, New Jersey, USA, 2008.
7. Yoder, E.J. and M.W. Witczak Principles of Pavement Design, Second Edition, John Wiley and Sons, New York, USA, 1975.

Course code	Course Title	Duration		L	T	P	C
M20TK0103	**Railways, Airways and Harbour Engineering**	**16 weeks**	**HC**	**2**	**1**	**0**	**3**
Internal assessment: 50 Marks	**Semester End Exam: 50 Marks (Minimum 20 Marks)**						

Course Prerequisite: None

Course Learning Objectives: Student will be able to learn

- Provides the basic knowledge about the railways and its components
- Provide the basic knowledge about the geometric design of railway tracks and its construction.
- Provides the basic knowledge about the geometric design of runways, Taxiways and Aprons.
- Provide basic knowledge about Harbour Planning.

Course Outcomes: At the end of the course, the student are expected to be able to

- Describe about railways and its components.
- Design the geometrics of the railways.
- Examine the factors governing planning and design of railway infrastructures.
- Design the geometrics of the airport infrastructure.
- Know the factors considered for selection of site for airport and harbour.
- Plan and design harbour facilities.

Mapping of Course Outcomes with programme Outcomes

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TK0103	CO1	3	2	2		2	3			3	2	2	3	2	1
	CO2	2	3	2		2	2				2		3	3	1
	CO3	3	2	2	1	1	2	2	3		2		3	2	2
	CO4	3	2	2	2	2		2		3	2	2	3	3	2
	CO5	2	3	2	2	1		2		2	3	2	3	2	2
	CO6	3	2	3	2		3	3	3		2	2	3	3	2

Weightage distribution for Assessment

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4
CO6		5	3	8	16	Level-5
Total Marks	15	15	20	50	100	
	6^{th} Week	12^{th} Week	14^{th} Week	17^{th}-20^{th} Week		

Course Contents:

Unit-1 **12 hours**

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

Unit-2 **12 hours**

Geometric design of railway track and construction: Field investigation, right of way and formation, geometric design elements and standards, speeds computation, string lining of curves, grade compensation, railway cant and cant deficiency, traction, practice with examples.

Unit-3 **12 hours**

Geometric Design of the Airfield : Airport classification; Runways: runway configurations, runway orientation, wind rose, estimating runway length, sight distance and longitudinal profile, transverse gradient, airfield separation requirements, obstacle clearance requirements; Taxiways and taxi lanes: Aprons; Control tower visibility requirements.

Unit-4 **12 hours**

Harbour Planning: Types of water transportation, water transportation in India, requirements of ports and harbours, classification of harbours, selection of site and planning of harbours, location of harbour, traffic estimation, master plan, ship characteristics, harbour design, turning basin, harbour entrances, type of docks, its location and number, Site investigations – hydrographic survey, topographic survey, soil investigations, current observations, tidal observations.

Readings and References:

1. Agarwal, M.M. Indian Railway Track, Prabha & Co., New Delhi, India, 1988.
2. Chandra S. and M. Agrawal, Railway Engineering, Second Edition, Oxford University Press, 2013.
3. Clifford F. Bonnett, Practical Railway Engineering, 2nd edition, imperial college press, London, 2005.
4. Gupta, B.L. Text Book of Railway Engineering, Standard Publishers, New Delhi, India, 1982.
5. Mundrey, J. S., Railway Track Engineering, Fourth Edition, TATA McGraw- Hill, New Delhi, 2009
6. Rangwala, S.C. Principles of Railway Engineering, Charotar Publishing House, Anand, India, 2009.
7. Saxena S.C. and S.P. Arora, A text book of Railway Engineering, Dhanpat Rai, 2010.
8. Seetharaman, S. Dock and Harbour Engineering, Umesh Publications, New Delhi, India, 1999.
9. Venkatramaiah, Transportation Engineering, Vol. 2: Railways, Airports, Docks and Harbours, Bridges and Tunnels, June 2017

Course code	Course Title	Duration		L	T	P	C
M20TK0104	Traffic Engineering	16 weeks	HC	2	1	0	3
Internal assessment: 50 Marks	Semester End Exam: 50 Marks (Minimum 20 Marks)						

Course Prerequisite: None

Course Learning Objectives: Student will be able to learn

- Provide an insight on traffic and its components, fundamental parameters of traffic.
- Explain the importance, data collection methods, analysis and interpretation of various traffic surveys.

- Explain the concept of capacity and level of service for different transportation facilities.
- Provide an insight on various control devices including signals and their coordination.

Course Outcomes: At the end of the course, the student is expected to be able to

- Estimate basic characteristics of traffic stream.
- Know the Engineering Studies, Analysis, data collection methods.
- Conduct traffic studies and analyze traffic data.
- Determine the capacity of different transportation facilities.
- Design traffic control devices like signals and their coordination.
- Estimate the progression on one-way streets and two-way streets.

Mapping of Course Outcomes with programme Outcomes:

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TK0104	CO1	3	2	3	3	3	3						3		1
	CO2	3	2	1	3		3						3	2	2
	CO3	3	3	3	3	2	2					3	3	3	1
	CO4	3	2		3		3					2	3	2	2
	CO5	2	3	3	3	2		1					3	3	2
	CO6	3	2	2	3		3					2	3	2	2

Weightage distribution for Assessment:

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4
CO6		5	3	8	16	Level-5
Total Marks	15	15	20	50	100	
	6^{th} Week	12^{th} Week	14^{th} Week	17^{th}-20^{th} Week		

Course Contents:

Unit-1 **12 hours**

Traffic Characteristics: Objectives and Scope of traffic engineering; Components of road traffic: Characteristics of Road users and vehicles; Fundamental parameters of traffic and relationships; Mesoscopic, Microscopic and Macroscopic characteristics of traffic stream. Numerical examples.

Unit-2 **12 hours**

Traffic Engineering Studies and Analysis: Importance, equipment, data collection methods, analysis and interpretation of the following studies: (i) Volume (ii) Speed (iii) Travel time and Delay (iv) Pedestrian (v) Parking; Advanced methods: GPS, Instrumented Vehicles, Image Processing, Bluetooth and Infrared methods. Applications.

Unit-3 **12 hours**

Highway Capacity: Capacity and level of service concepts; Factors affecting capacity and LOS; Freeway and multi-lane capacity analysis; Capacity of Urban Roads; Capacity of weaving sections; Intersection capacity analysis; US Highway Capacity Manual (HCM) and IRC standards, Indo-HCM standards. Numerical examples.

Unit-4 **12 hours**

Traffic control devices: Traffic signs, Markings, Islands and Signals; Different methods of signal design; Signal co-ordination: Concepts of signal coordination, Signal progression on one-way streets and two-way streets, Bandwidth concept, forward and Reverse progressions. Numerical examples.

Readings and References:

1. C. Jotin Khisty and B. Kent Lall, Transportation Engineering: An Introduction, 3rd Edition, Pearson, 2016.
2. C.S. Papacostas and P.D. Prevedouros, Transportation Engineering and Planning, Third Edition, Prentice Hall of India Pvt. Ltd., 2015
3. Chakroborty Partha, Das Animesh, Principles of Transportation Engineering, PHI Learning Pvt. Ltd., 1st Edition, 2009.
4. Highway Capacity Manual 2010, Transportation Research Record, Transportation Research Board, Washington, D.C., 2010
5. Indian Highway Capacity Manual (Indo HCM), CSIR-CRRI, New Delhi, 2017.
6. L.R. Kadiyali, Traffic Engineering and Transportation Planning, Khanna Publishers, 2012.
7. Louis J. Pignataro, Traffic Engineering: Theory and Practice 1st Edition, Prentice Hall, 1973
8. May, A.D. Traffic Flow Fundamentals, 1st Edition, Prentice Hall, 1990.
9. Nicholas J. Garber and Lester A. Hoel, Traffic and Highway Engineering, 5th edition (SI), Cengage Learning, Reprint 2017.
10. Roger P. Roess, Elena S. Prassas and William R. McShane, Traffic Engineering, Fifth Edition, Pearson, 2019.

Course code	Course Title	Duration		L	T	P	C
M20TK0105	**Transportation Data Analysis**	**16 weeks**	**HC**	**2**	**1**	**0**	**3**
Internal assessment: 50 Marks		**Semester End Exam: 50 Marks (Minimum 20 Marks)**					

Course Prerequisite: None

Course Learning Objectives: Student will be able to learn

- Explain the description and presentation of real data
- Explain the testing of hypothesis with a help of different statistical tests
- Provides the knowledge about multiple linear regression and correlation analysis.
- Explain the estimation of parameters of different poly nominal equations using curve fitting methods.

Course Outcomes: At the end of the course, the student are expected to be able to

- Presentation of transportation data
- Testing of hypothesis with a help of different statistical tests
- Test hypothesis using goodness of fit measures.
- Carry out multivariate data analysis and identify correlations.
- knowledge about multiple linear regression and correlation analysis
- Estimate Parameters using appropriate techniques.

Mapping of Course Outcomes with programme Outcomes

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TK0105	CO1	3		3	3	3	3						3		1
	CO2	2	3	2	3		2					3	3	2	1
	CO3	3	3	3	3		2					3	3	3	1
	CO4	2	3	2	3		2					3	3	3	2
	CO5	3	2		3		3						3	2	2
	CO6	2	3	3	3	2		1					3	3	2

Weightage distribution for Assessment

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4
CO6		5	3	8	16	Level-5
Total Marks	15	15	20	50	100	
	6^{th} Week	12^{th} Week	14^{th} Week	17^{th}-20^{th} Week		

Course Contents

Unit-1 **12 hours**

Data Description and Presentation: Type of data, center of data, quartiles, five number summary, spread of data, coefficient of variation and standard deviation, measure of dispersion, shape of data, coefficients of skewness and kurtosis, descriptive data statistics, presentation of categorical, quantitative and qualitative variable, data frequency and histogram, exercises with real data.

Unit-2 **12 hours**

Statistical Inference and Tests of Significance: Hypothesis testing, types of error in hypothesis, confidence interval, significance tests for comparing variances and means, tests with small and large samples, two-tail and one-tail student's t-test, analysis of variance (ANOVA), non-parametric tests (Chi-square test and Kolmogorov–Smirnov test), central limit theorem, practice with transportation data.

Unit-3 **12 hours**

Regression and Correlation: Simple linear regression, residuals and variances, multiple linear regression, two stage regression, forward, backward and step-wise regression, residual analysis, correlation analysis, type of correlations, coefficient of correlation, Karl-Pearson's coefficient, multivariate data analysis, factor analysis, applications in transportation engineering.

Unit-4 **12 hours**

Parameter Estimation and Curve Fitting Techniques: Least square, generalised least squares, method of moments, maximum likelihood, algebraic and geometric curve fit, linear and non-linear curve fitting (polynomial, exponential, logarithmic, power etc.), over fit and under fit, exercises with real data.

Readings and References:

1. Alfredo H.S. Ang and Wilson H. Tang, Probability Concepts in Engineering Planning and Design, Volume I & II, John Wiley & Sons, Singapore, 2007
2. Blank L., *Statistical procedures for engineering, management, and science*. McGraw Hill, Book, London, 1990.
3. Bovas A., Nair N. U., *Quality improvement through statistical method,* Springer Science &Business Media, 1998.
4. F.D. Hobbs, Traffic Planning and Engineering, 2nd Edition, Elsevier, 1979
5. Joseph F. Hair, William C. Black, Barry J. Babin and R. Anderson E.*, Multivariate data analysis*, 7th Edition, Prentice Hall, 2010
6. P.N. Arora, S. Arora, Arora A., *Elements of statistical method*, S. Chand & Company LTD., New Delhi, 2009.
7. Richard Haberman, *Mathematical Models*, 1st Edition, Society for Industrial and Applied Mathematics, 1999.
8. Robert V. Hogg, and Elliot Tanis and Dale Zimmerman, *Probability and Statistical Inference*, 9th Edition, Pearson, 2014
9. Simon P. Washington, Matthew G. Karlaftis, Fred L Mannering, *Statistical and econometric methods for transportation data analysis*, Second Edition, CRC Press,

Course code	Course Title	Duration		L	T	P	C
M20TK0106	Urban Transport Planning	16 weeks	HC	2	1	0	3
Internal assessment: 50 Marks		Semester End Exam: 50 Marks (Minimum 20 Marks)					

Course Prerequisite: None

Course Learning Objectives: Student will be able to learn

- Outline the urban transportation problems and urban travel demand.
- Explain the methods of data collection and inventories.
- Introducing four stages of urban transportation planning i.e., trip generation, trip distribution, mode choice modeling and route assignment.
- Explain the Corridor Identification, Master plan preparation and evaluation.

Course Outcomes: At the end of the course, the student is expected to be able to

- Identify urban transportation problems and estimate urban travel demand.
- Carry out multivariates of travel demand modellings and travel attributes.
- Analyze the required data by performing Transportation surveys.
- Plan urban transport networks.
- Ability to analyse the various mode split and traffic assignment techaniques.
- Identify urban transport corridors and Prepare urban transportation plans.

Mapping of Course Outcomes with programme Outcomes

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TK0106	CO1	2	2		2	3		2					1	2	1
	CO2	2	2		2	3		2				3	1	1	2
	CO3	2				2		3					1	2	1
	CO4	2	3	2		3		3				2	1	2	2
	CO5	2	2		2	1		2				3	2	1	2
	CO6	2	3	2		3		3				2	1	2	2

Weightage distribution for Assessment

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3

CO3	**5**		**3**	**8.5**	**16.5**	**Level-4**
CO4		**5**	**4**	**8**	**17**	**Level-4**
CO5		**5**	**3**	**9**	**17**	**Level-4**
CO6		**5**	**3**	**8**	**16**	**Level-5**
Total Marks	**15**	**15**	**20**	**50**	**100**	
	6th Week	**12th Week**	**14th Week**	**17th-20th Week**		

Course Contents:

Unit-I 12 hours

Urban Transportation Problems & Policy: Urban transportation Issues; Travel Characteristics; Evolution of Planning Process; Supply and Demand – Systems approach.

Travel Demand Modelling: Trends; Overall Planning process; Long term - Short term planning; Demand Function; Independent Variables; Travel Attributes; Assumptions in Demand Estimation; Sequential and Simultaneous Approaches; Aggregate and Disaggregate Techniques, Tour based models, and Activity based models.

Unit-II 12 hours

Data Collection and Inventories: Collection of data: Organization of surveys and Analysis, Study Area, Zoning, Types and Sources of Data, Road Side Interviews, Home Interview Surveys, Commercial Vehicle Surveys, Sampling Techniques, Expansion Factors, Accuracy Checks, Use of Secondary Sources

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

Unit-III 12 hours

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

Mode Split Analysis: Mode Choice Behavior, Competing Modes, Mode Split Curves, Models and Probabilistic Approaches – Logit Model

Unit-IV 12 hours

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

Corridor Identification - Plan preparation and evaluation: Master plans, Selection of Corridor, Corridor Identification, Corridor deficiency Analysis; TOD; Travel Forecasts to Evaluate Alternative Improvements, Impacts of New Development on Transportation Facilities; Pivot Point Analysis, Environmental and Energy Analysis.

Readings and References:

1. C. Jotin Khisty and B. Kent Lall, Transportation Engineering: An Introduction, 3rd Edition, Pearson, 2016.
2. C.S. Papacostas and P.D. Prevedouros, Transportation Engineering and Planning, Third Edition, Prentice Hall of India Pvt. Ltd., 2015
3. Hutchinson, B.G., Principles of Urban Transport Systems Planning, McGraw Hill, 1974.
4. Juan de Dios Ortuzar and Luis G. Willumsen, *Modelling Transport, 4th Edition*, John Wiley and Sons, 2011.
5. Michael D. Meyer, Transportation Planning Handbook, Fourth Edition, Institute of Transportation Engineers, John Wiley & Sons Inc., 2016
6. Michael D. Meyor and Eric J. Miller, Urban Transportation Planning: A decision oriented Approach, Second Edition, McGraw Hill, 2001.
7. Michael J. Bruton, Introduction to Transportation Planning, UCL Press, London, UK, 2000.

Course code	Course Title	Duration		L	T	P	C
M20TK0107	**Traffic & Pavement Engineering laboratory**	**16 Weeks**	Practical/ HC	**0**	**0**	**2**	**2**
Internal assessment: 20 Marks		**Semester End Exam: 30 Marks(Minimum 08 Marks)**					

Course Prerequisite: None

Course Learning Objectives: Student will be able to learn

- Explain the importance, data collection methods, analysis and interpretation of various traffic surveys
- Explain the concept of capacity and level of service for different transportation facilities.
- Provide the overview about pavement materials and tests to be carried out.
- Explain the stress analysis in flexible pavements and rigid pavements.

Course Outcomes: At the end of the course, the student is expected to be able to

- Conduct all types of traffic studies.
- To analyse the Gaps, Lags, Critical Gaps at Intersections
- Determine the capacity and level of service of a highway section.
- Perform laboratory test on aggregates, bitumen and bitumen mixes.
- Evaluate the functional and structural response characteristics of in-service pavements.
- Plan the parking studies in urban areas.

Mapping of Course Outcomes with programme Outcomes

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TK0107	CO1	3	2	2		2	3			3	2	2	3	2	1
	CO2	3	2	2	2	2		2		3	2	2	3	3	2
	CO3	3	2	2	1	1	2	2	3		2		3	2	2
	CO4	3	2	2	2	2		2		3	2	2	3	3	2
	CO5	3	2	3	2		3	3	3		2	2	3	3	2
	CO6	3	2	2	2	2		2		3	2	2	3	3	2

Course Contents

PART-1 12 hours

1. **Volume studies:**

   Direction, Duration and Classification of Traffic Volume at Mid-Block Section and Intersections, Manual, and Mechanical Methods, Headway Distributions

2. **Speed studies:**

   Spot Speed Studies – Manual and video-graphic method

3. **Journey time and delay studies:**

   Travel Time and Delay Studies by Floating Car Method

4. **Gap acceptance studies:**

   Study of Gaps, Lags, Critical Gaps at Intersections

5. **Intersection delay studies:**

   Delay Measurement at Uncontrolled Intersections and Signalized Intersections

6. **Parking surveys:**

   Parking Inventory and Turnover Studies

7. **Highway Capacity Estimation:**

   Video-graphic method, Dynamic PCU

PART-2 12 hours

1. **Tests on Aggregate:** aggregate gradation, shape tests, specific gravity, water absorption.
2. **Tests on Aggregate:** Los Angeles abrasion value, aggregate impact value, soundness test.
3. **Tests on Bitumen:** penetration, absolute and kinematic viscosity, flash and fire point, ductility and elastic recovery, softening point, specific gravity.
4. **Tests on Bituminous Mixes:** stripping value of aggregate and Marshall mix design.
5. **Tests on Bituminous Mixes:** bitumen content and gradation using centrifuge extractor and NCAT ignition oven, determination of tensile strength ratio for a given bitumen mix.
6. **Field Evaluation:** pavement condition rating, unevenness using MERLIN.
7. **Field Evaluation:** Dynamic Cone Penetrometer, Clegg Impact Test, determination of modulus and rebound deflection using Portable Falling Weight Deflectometer.

Readings and References:

1. C. Jotin Khisty and B. Kent Lall, Transportation Engineering: An Introduction, 3rd Edition, Pearson, 2016
2. L.R. Kadiyali, Traffic Engineering and Transportation Planning, Khanna Publishers, 2012.
3. Louis J. Pignataro, Traffic Engineering: Theory and Practice 1st Edition, Prentice Hall, 1973
4. Roger P. Roess, Elena S. Prassas and William R. McShane, Traffic Engineering, Fifth Edition, Pearson, 2019.
5. Thomas R. Currin, Introduction to Traffic Engineering: Manual For data Collection & Analysis, 2nd Edition, CL Engineering, 2012.
6. Central Materials Laboratory Testing Manual, 2000, the United Republic of Tanzania, Ministry of Works.
7. Huang, Y.H. Pavement Analysis and Design, Second Edition, Dorling Kindersley (India) Pvt. Ltd., New Delhi, India, 2008.
8. S.K. Khanna, C.E.G. Justo, and A. Veeraragavan, *Highway Materials and Pavement Testing*, 5th Edition, Nem Chand and Bros, Roorkee, India, 2009.
9. Relevant IS, IRC, ASTM Codes.

Course code	Course Title	Duration		L	T	P	C
M20TK0108	Mini project-I	16 Weeks	Practical	0	0	2	2
Internal assessment: 50 Marks		Semester End Exam: 50 Marks (Minimum 20 Marks)					

Course Prerequisite: None

Course Learning Objectives:

Course Outcomes: At the end of the course, the student is expected to be able to

- Conceptualize, design and implement solutions for specific problems.
- Communicate the solutions through presentations and technical reports.
- Apply resource managements skills for mini projects.
- Synthesize self-learning, team work and ethics.
- To inculcate innovative thinking and thereby preparing students for main project.
- To provide students hands on experience on, troubleshooting, maintenance, innovation, record keeping, documentation etc thereby enhancing the skill and competency part of technical education.

Mapping of Course Outcomes with programme Outcomes

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TK0108	CO1	2	2	3	3	3			2		3	3	3	2	1
	CO2					3			3	3	3	1	2	2	2
	CO3	3	3	2		2	2	3			2	3	2	2	3
	CO4		2				3	2	2	2	3		2	2	3
	CO5	3	2	3		3	3	3	2	3	2		2	2	2
	CO6	2	3	2		3	2	2	2	3	3	3	2	2	2

Course Contents

There is no prescribed syllabus. Students are required to search, collect and review various research articles published in chosen area of research. A student has to select a area for his mini project, based on his/her interest. A student shall be required to submit a mini project report on the research work carried out by him/her and give presentation to the Assessment Committee (AC) in the presence of their classmates. It is mandatory for all the students to attend the presentations of their classmates.

Readings and References:

1. Research Articles / Reports available on Internet
2. Transportation Engineering Journals
3. Transportation Engineering Textbooks and Handbooks

SECOND SEMESTER

Course code	Course Title	Duration		L	T	P	C
M20TK0201	Applied Traffic Engineering	16 Weeks	HC	2	1	0	3
Internal assessment: 50 Marks		Semester End Exam: 50 Marks (Minimum 20 Marks)					

Course Prerequisite: Traffic Engineering

Course Learning Objectives: Student will be able to learn

- Outline the various traffic stream models.
- Provide an insight into vehicle arrivals, gaps and headways at midblock and uncontrolled intersections.
- Provide a step by step procedure of traffic simulation
- Explain pedestrian behavior and its modeling by using different techniques.

Course Outcomes: At the end of the course, the student is expected to be able to:

- Develop traffic stream models.
- Analyse the headways and gaps of vehicles at mid blocks and intersections.
- Simulate traffic at mid blocks and intersections.
- Analyse and develop Pedestrian stream models.
- Study and evaluation of basic concepts for traffic flow and pedestrian flow modeling
- Application of statistically software analysis and usage of data collection methods for traffic flow and pedestrian flow modeling.

Mapping of Course Outcomes with programme Outcomes:

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TK0201	CO1	3	3	2		3			3				3	2	1
	CO2		3	3		3						3	3	3	1
	CO3	3	2	3	3		3						3	2	2
	CO4	2	3	3	3	2	3						3	3	2
	CO5	3	1	2	1	2	1					3	2	1	2
	CO6	2	3	3	3	2	3						3	3	2

Weightage distribution for Assessment:

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4
CO6		5	3	8	16	Level-5
Total Marks	15	15	20	50	100	
	6th Week	12th Week	14th Week	17th-20th Week		

Course Contents:

Unit-I 12 hours

Traffic Flow Modeling: Fundamental diagrams of traffic flow, family of models; Continuity equation, LWR model, Regime based macroscopic models; Car-following models and queuing analysis; Picoscopic modelling – Applications. Numerical examples.

Unit-II 12 hours

Probabilistic Aspects of Traffic Flow: Spacing and Headway characteristics, Poisson distribution of vehicle arrivals; Gap and headway distribution. Exponential, shifted exponential and other distributions; Critical Gap estimation at uncontrolled intersection. Applications and numerical examples.

Unit-III 12 hours

Traffic simulation: Fundamentals of simulation, Components of traffic simulations models; Examples of Macro, Meso, and Microscopic based simulation models; Calibration and validation definitions, methodology for calibrating and validating a microscopic traffic simulation model; Calibration and validation guidelines, data requirements, Goodness-of-fit measures. Case studies.

Unit-IV 12 hours

Pedestrian Flow Modeling: Pedestrian behavior, Pedestrian interactions, Pedestrian facilities; Pedestrian behavioral models; Social-force models; Pedestrian stream models, Pedestrians simulation. Applications and case studies.

Readings and References:

1. Banks, J; Carson, JS; Nelson, B.L. Discrete-event system simulation. 5th Edition, Upper Saddle River, NJ: Prentice-Hall, 2010.

2. Barceló, J. "Models, Traffic Models, Simulation, and Traffic Simulation". Barceló, J. ed. Fundamentals of traffic simulation. New York: Springer, 2010.
3. Fred L. Mannering, Scott S. Washburn, Kilareski Walter P., Principles Of Highway Engineering And Traffic Analysis, 4th Edition, Wiley India Pvt Ltd., 2011.
4. Highway Capacity Manual 2010, Transportation Research Record, Transportation Research Board, Washington, D.C., 2010
5. May, A.D. Traffic Flow Fundamentals, 1st Edition, Prentice Hall, 1990.
6. Roger P. Roess, Elena S. Prassas and William R. McShane, Traffic Engineering, Fifth Edition, Pearson, 2019.

Course code	Course Title	Duration		L	T	P	C
M20TK0202	**Pavement Construction, Evaluation and Management system**	**16 weeks**	**HC**	**2**	**1**	**0**	**3**
Internal assessment: 50 Marks	**Semester End Exam: 50 Marks (Minimum 20 Marks)**						

Course Prerequisite: Pavement Materials, Analysis and Design

Course Learning Objectives: Student will be able to learn

- Outline the various pavement failures, causes and remedial measures
- Explain various methods of finding functional condition of pavements
- Explain various methods of finding structural condition of pavements
- Discuss the need of PMS in planning and maintaining the flexible pavements.
- Discuss the need of PMS and models to estimate the performance of pavements.

Course Outcomes: At the end of the course, the student is expected to be able to:

- Prepare quality assurance and quality control plans to construct better performing pavements.
- Develop an understanding on the pavement evaluation case studies.
- Evaluate the pavements based on the functional characteristics.
- Evaluate the pavements based on the structural characteristics.
- Develop and validate models for predicting pavement performance.
- Prepare a strategy onevaluation and maintenancescheme for pavements.

Mapping of Course Outcomes with programme Outcomes:

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TK0202	CO1	3	3	2									2	2	1
	CO2	2	3	3	3	2		1					3	3	2
	CO3	3	3	2		2			1				2	2	1
	CO4	3	3							3			3	2	2
	CO5	3	3	2	3				1	3		3	3	2	2
	CO6		2		3			1		2			3		2

Weightage distribution for Assessment:

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4
CO6		5	3	8	16	Level-5
Total Marks	15	15	20	50	100	
	6^{th} Week	12^{th} Week	14^{th} Week	17^{th}-20^{th} Week		

Course Contents:

Unit-I 12 hours

Pavement Construction: Construction and preparation of sub-grade soil, construction of sub-base layer, construction of base layer, construction of bituminous surface layers, construction of cement concrete surface layer and MoRTH specifications.

Unit-II 12 hours

Functional Evaluation of Pavements: Introduction, factors affecting pavement deterioration, functional condition evaluation techniques, roughness measurements, Identification of uniform sections, serviceability concepts, visual and ride rating techniques.

Unit-III 12 hours

Structural Evaluation of pavements: Structural condition evaluation techniques, NDT procedures, rebound deflection, deflection bowl measurement and analysis, IRC overlay design method, structural evaluation using falling weight deflectometer, back calculation of layer moduli, ground penetrating radar for pavement evaluation, And evaluation of pavement safety: skid resistance and hydroplaning.

Unit-IV **12 hours**

Introduction to PMS: Basic components of PMS, Network and Project levels of PMS, Functions of PMS**. Pavement Performance Models:** Concepts, pavement evaluation with respect to user cost, technologies, techniques for developing prediction models deterministic, probabilistic, expert system of PMS models; remaining service life, AASHO, CRRI and HDM models, deterioration concepts and modeling, priority programming methods, pavement life cycle cost analysis, decision tree, PMS analysis software.

Readings and References:

1. Croney, D. and P. Croney, The design and performance of road pavements, McGraw-Hill Book Company, London, UK, 1991.
2. Haas, R., W.R. Hudson and J.P. Zaniewski, Modern Pavement Management, Krieger Publishing Company, Malabar, Florida, USA, 1994.
3. Huang, Y.H. Pavement Analysis and Design, Second Edition, Dorling Kindersley (India) Pvt. Ltd., New Delhi, India, 2008.
4. Mallick, R.B. and T. El-Korchi, Pavement Engineering – Principles and Practice, CRC Press, Taylor and Francis Group, Florida, USA, 2009.
5. Ministry of Road Transport and Highways, Specifications for Road and Bridge Works, Fifth Edition, Indian Roads Congress, New Delhi, India, 2013.
6. P.S Kandhal, Bituminous Road Construction India, Revised Edition, December 2017.
7. Papagiannakis, A.T. and E.A. Masad, Pavement Design and Materials, John Wiley and Sons, New Jersey, USA, 2008.
8. Relevant Indian Road Congress codes, Bureau of Indian Standards and International standards such as ASTM and AASHTO.
9. Haas, R., W. R. Hudson, and J. P. Zaniewski. Modern Pavement Management. Krieger Publishing Company. Malabar, Florida, 1994.

Course code	Course Title	Duration		L	T	P	C
M20TKS211	**Intelligent Transportation Systems**	**16 weeks**	**SC**	**2**	**1**	**0**	**4**
Internal assessment: 50 Marks	**Semester End Exam: 50 Marks (Minimum 20 Marks)**						

Course Prerequisite: None

Course Learning Objectives: Student will be able to learn

- Provide an insight of various taxonomy of ITS and its user services.
- Explain the various components of ITS, tools and technologies.
- Explain the design and implementation of different suitable ITS solutions
- Provide knowledge about various ITS technologies around the world

Course Outcomes: At the end of the course, the student is expected to be able to:

- Differentiate ITS user services and its components.
- Understand the Infrastructure based servicesand vehicle based services
- Determine the suitable ITS technology and assess its effectiveness to solve transportation problems.
- Differentiate the advanced public transportation system, advanced rural transportations, security.
- Design and implement the suitable ITS solutions for safe and sustainable transportation
- Understand the challenges of ITS technologies around the world

Mapping of Course Outcomes with programme Outcomes:

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TKS211	CO1	3		3									2	2	1
	CO2	2		3									2	2	1
	CO3	3	3	3									3	2	1
	CO4	3	3	2									3	3	2
	CO5	3	3	3		2				2	2		3	2	2
	CO6		3		2	2	2			2	2	2	2	3	2

Weightage distribution for Assessment:

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4
CO6		5	3	8	16	Level-5
Total Marks	15	15	20	50	100	
	6^{th} Week	12^{th} Week	14^{th} Week	17^{th}-20^{th} Week		

Course Contents:

Unit-I **12 hours**

ITS Background and Telemetric systems: Definitions, features and objectives of ITS; History of ITS and its development over the world; ITS taxonomy, ITS application areas, uses, and application overview. ITS User Services: Infrastructure based services, intelligent vehicle based services.

Unit-II **12 hours**

ITS components, tools and strategies : Components of user services; advanced traffic management system, advanced traveler information system, advanced vehicle control system, commercial vehicle

operational management, advanced public transportation system, electronic payment system, advanced rural transportations, security and safety systems, urban traffic control, SCOOT and SCAT systems, benefits and limitations.

Unit-III **12 hours**

Design and implementation: Design components; data acquisition methods, equipment and used technology, radar and sensor, detectors, vehicle identifiers, and GPS, Communication tools; DSRC, Worldwide ITS implementation and challenges, case studies.

Unit-IV **12 hours**

ITS Standards: ITS standards, development process, legal issues, financial issues, Mainstreaming ITS; Integration and up gradation; Future of ITS. **Case studies:** Issues and challenges of ITS in developed and developing countries.

Readings and References :

1. Chowdhury, M. A. and Sadek, A, Fundamentals of Intelligent Transportation Systems Planning, Artech House, 2003.
2. IET Intelligent Transport Systems and 15th International IEEE Conference on Intelligent Transportation Systems (ITSC), 16-19 September, 2012. (http://digital-library.theiet.org/content/journals/iet-its)
3. J.M. Sussman, *Perspectives on Intelligent Transportation Systems* (ITS), Springer, 2005
4. Pradip Kumar Sarkar and Amit Kumar Jain (2018), Intelligent Transportation Systems, PHI learning Private Limited, New Delhi.
5. R. Stough, Intelligent Transport Systems: Cases and Policies, Edward Elgar, 2001, Artificial

Course code	Course Title	Duration		L	T	P	C
M20TKS212	**IoT applications in Transportation**	**16 weeks**	**SC**	**2**	**1**	**0**	**3**
Internal assessment: 50 Marks	**Semester End Exam: 50 Marks (Minimum 20 Marks)**						

Course Prerequisite: None

Course Learning Objectives: Student will be able to learn

- Provides the basic knowledge about IoT in Transportation.
- Provides an insight about future transportation by implementing IoT in Transportation.
- Explain the concept of IoT in Smart Cities.
- Provides the basic knowledge about Vehicular cloud computing.

Course Outcomes: At the end of the course, the student is expected to be able to:

- List of IoT Applications and challenges in Transportation
- Understanding of new technologies implemented in transportation.
- Ability to apply IoT in smart cities concept.
- Understanding of Vehicular cloud computing.
- Analysis of IoT and future of transportation demand.
- Understanding, strategies, and application of various case studies for smart cities.

Mapping of Course Outcomes with programme Outcomes:

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TKS212	CO1	3		3									2	2	1
	CO2	3	3	3									3	2	1
	CO3	3	3	3		2				2	2		3	2	2
	CO4	2	3		2	2	2			2	2	2	2	3	2
	CO5	2	3	1	2		2			2	2	2	2	3	2
	CO6		3		2	2	2			2	2	2	2	3	2

Weightage distribution for Assessment:

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4
CO6		5	3	8	16	Level-5
Total Marks	15	15	20	50	100	
	6^{th} Week	12^{th} Week	14^{th} Week	17^{th}-20^{th} Week		

Course Contents:

Unit-I **12 hours**

IoT in Transportation: Benefits, Challenges, and Uses, IoT scenarios in transportation, Challenges of IoT deployment, Building a secure IoT network infrastructure: IoT containment, In-depth security, End-to-end operational and network management. Applications.

Unit-II **12 hours**

IoT and future of transportation: Introduction, Use cases of IoT in transportation: Connected cars, Vehicle tracking systems, Public transport management, Traffic management, Fleet management; Value of IoT for transport ecosystems. Case studies.

Unit-III **12 hours**

IoT in Smart Cities: IoT's role in Smart Cities: Definition, Framework, Typical Smart City Solutions and Application in Smart Cities; Benefits of IoT; Challenges in Adaption of IoT by Cities, Smart Projects: Jaipur Smart City, Nagpur Smart City, Pune Smart City, Vizag Smart City.

Unit-IV **12 hours**

Vehicular cloud computing: Vehicular cloud computing, Vehicular cloud abstraction, Taxonomy of vehicular clouds: Cloud formation, Cloud types and Basic services, VCC based Traffic management systems, Potential issues and future challenges: Traffic management challenges, Communication challenges etc.

Readings and References :

1. Ahmad et., 2017. Characterizing the role of vehicular cloud computing in road traffic management , International Journal of Distributed Sensor Networks, Vol. 13(5).

E-Learning and Web References:

1. https://www.al-enterprise.com/-/media/assets/internet/documents/iot-for-transportation-solutionbrief-en.pdf
2. https://www.wfeo.org/wp-content/uploads/stc-information/L2-IoT_in_Smart_Cities-By-R_Srinivasan.pdf
3. https://mobility.here.com/learn/smart-transportation/introduction-smart-transport

Course code	Course Title	Duration		L	T	P	C
M20TKS221	Geometric Design of Highways	16 weeks	SC	2	1	0	3
Internal assessment: 50 Marks		Semester End Exam: 50 Marks (Minimum 20 Marks)					

Course Prerequisite: None

Course Learning Objectives: Student will be able to learn

- Explain the design of the highway cross section elements.
- Explain the design of the horizontal and vertical alignment of highways.
- Explain the design of un-signalized and signalized intersections for given traffic conditions.
- Explain the design of the bicycle and pedestrian facilities.

Course Outcomes: At the end of the course, the student is expected to be able to:

- Carry out geometric design of highway cross sectional elements.
- Ability to estimate the SSD, OSD & ISD for design of various geometric cross sectional elements.
- Carry out geometric design of horizontal and vertical curves.
- Ability to plan and design of at-grade intersections & its types for easy and efficient traffic movements.
- Design and evaluate un-signalized and signalized intersections for given traffic conditions.
- Design and evaluate bicycle and pedestrian facilities

Mapping of Course Outcomes with programme Outcomes:

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TKS221	CO1	3	3	3		2	2	3	3		3		3	2	2
	CO2	3	2	2	1	3	2	3	2		3		2	3	2
	CO3	3	3	3	1	3	1	3	3		3		3	3	2
	CO4	3	2	3	2	3	1	3	2		3		3	3	2
	CO5	3	3	3	1	3	1	3	3		3		3	3	2
	CO6	3	2	3	2				3		2		3	2	1

Weightage distribution for Assessment:

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4
CO6		5	3	8	16	Level-5
Total Marks	15	15	20	50	100	
	6^{th} Week	12^{th} Week	14^{th} Week	17^{th}-20^{th} Week		

Course Contents

Unit-1 **12 hours**

Highway Geometric design: Elements of geometric design, Highway cross section elements: Pavement surface characteristics, Camber, Carriageway, Kerbs etc., Sight distance: Stop sight distance, stopping distance at slopes, Overtaking sight distance and sight distance at intersection. Numerical examples.

Unit-2 **12 hours**

Design of Horizontal alignment: Design speed, Horizontal curves, super elevation, Super elevation design, Radius of horizontal curve, extra widening on curves, Horizontal transition curve, Set-back distance and curve resistance. Numerical examples. **Design of vertical alignment:** Types of vertical curves, Length of summit curve and Length of valley curve. Numerical examples.

Unit-3 **12 hours**

Design of at grade intersections: Types of at-grade intersections, factors affecting design, intersection traffic control, conflict points, uncontrolled intercession analysis, capacity of rotary, analysis of roundabouts, warrants for signalization, design of signalized intersection, saturation flow rate and capacity, design of all aspects of signal timings, analysis of delay and queue length level-of-service analysis.

Unit-4 **12 hours**

Design of Bicycle and Pedestrians Flow Facilities:

Bicycle flow characteristics, performance measures, bikeway capacity, bicycle flow facilities, evaluation of urban street for bicycle path, control delay and LOS analysis.

Pedestrian flow characteristics, performance measures, design and evaluation of pedestrian facility at intersections, sidewalk and crosswalk design, pedestrian signals, and design examples.

Readings and References:

1. C. Jotin Khisty and B. Kent Lall, Transportation Engineering: An Introduction, 3rd Edition, Pearson, 2016
2. Fred L. Mannering, Scott S. Washburn, Kilareski Walter P., Principles Of Highway Engineering and Traffic Analysis, 4th Edition, Wiley India Pvt Ltd., 2011.
3. Highway Capacity Manual 2010, Transportation Research Record, Transportation Research Board, Washington, D.C., 2010
4. Indian Highway Capacity Manual (Indo HCM), CSIR-CRRI, New Delhi, 2017.
5. L.R. Kadiyali, Traffic Engineering and Transportation Planning, Khanna Publishers, 2012.
6. Nicholas J. Garber and Lester A. Hoel, Traffic and Highway Engineering, 5th edition (SI), Cengage Learning, Reprint 2017.
7. Roger P. Roess, Elena S. Prassas and William R. McShane, Traffic Engineering, Fifth Edition, Pearson, 2019.
8. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., 'Highway Engineering', NemChand and Bros, Roorkee – 2014.

Course code	Course Title	Duration		L	T	P	C
M20TKS222	Road Safety and Management	16 Weeks	SC	2	1	0	3
Internal assessment: 50 Marks		Semester End Exam: 50 Marks (Minimum 20 Marks)					

Course Prerequisite: None

Course Learning Objectives: Student will be able to learn

- Explain different parameters responsible for road accident and Black spot identification methods
- Describe the step by step procedure of road safety audit.
- Discuss various plans and strategies for reducing accident rate
- Explain the different Mitigation measures to prevent accidents.

Course Outcomes: At the end of the course, the student is expected to be able to:

- Analyze the effect of driver characteristics, roadway characteristics, and climatic factors on safety
- Understand the Artificial intelligence and machine learning in black spot identifications
- Conduct road safety audits at various stages of road development.
- Plan and design of road safety improvement programs.
- Analyze accident data and suggest safety measures.
- Analyze a highway geometry and road safety law.

Mapping of Course Outcomes with programme Outcomes:

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TKS222	CO1	2		3	2	3	1	1			2	3	3	3	
	CO2														
	CO3	2	2	2	3	3				3	2		3	3	
	CO4	3	2		2	3	3	2		2	3		3	2	1
	CO5	2	3		3	2	2		1		3		3	2	1
	CO6	2	2		2	3	2	2	1		2		2	2	1

Weightage distribution for Assessment:

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4
CO6		5	3	8	16	Level-5

Total Marks	15	15	20	50	100	
	6th Week	12th Week	14th Week	17th-20th Week		

Course Contents:

Unit-1 12 hours

Road Safety Trends and Factors: Road accidents, Trends, causes, Collision diagrams; Highway safety; Human factors and road user limitations; Speed and its effect on road safety; Vehicle factors; **Black Spot Identification Methods and Investigations:** Multiple linear and logistic methods, GIS based identification, Artificial intelligence and machine learning in black spot identifications, Case Studies.

Unit-2 12 hours

Road Safety Audits: Key elements of a road safety audit, Road Safety Audits & Investigations, Work zone safety audit; Crash investigation and analysis, Methods for identifying hazardous road locations, Case Studies, Relevant IRC and IRF practices.

Unit-3 12 hours

Road Safety Management System: Multi-causal dynamic systems approach to safety; Road safety improvement strategies; Elements of a road safety plan, Safety data Needs; Safe vehicle design.

Unit-4 12 hours

Mitigation Measures: Accident prevention by better planning, Accident prevention by better design of roads, Crash Countermeasures, Highway operation and accident control measures, Highway Safety Measures during construction, Highway geometry and safety; Safety in urban areas; Public transport and safety; Road safety policy making, Stakeholders involvement; Road safety law.

Readings and References:

1. 1.Geetam Tiwari and Dinesh Mohan, Transport Planning and Traffic Safety: Making Cities, Roads, and Vehicles Safer, CRC Press, 2016.
2. Institute of Transportation Engineers (ITE), The Traffic Safety Toolbox: A Primer on Traffic Safety, ITE, 1999.
3. IRC: SP:44-1996: Highway Safety Code, The Indian Roads Congress, New Delhi, 1996.
4. IRC: SP-88-2010: Road Safety Audit Manual, The Indian Roads Congress, New Delhi, 2010.
5. IRC:SP: 55-2014: Guidelines on Traffic Management in Work Zones, The Indian Roads Congress, New Delhi, 2014
6. J. Stannard Baker, Traffic Collision Investigation, Northwestern University Center for Public Safety, 2002.
7. Road Traffic and Work Zone Safety Manual, National Highway Authority of India, 2012.
8. Rune Elvik and TrulsVaa, The Handbook of Road Safety Measures, Elsevier, 2004.

Course code	Course Title	Duration		L	T	P	C
M20TKS231	GIS applications in Transportation Engineering	16 Weeks	SC	2	1	0	3
Internal assessment: 50 Marks		Semester End Exam: 50 Marks (Minimum 20 Marks)					

Course Prerequisite: None

Course Learning Objectives: Student will be able to learn

- Explain different GIS data modeling techniques.
- Discuss the various data sources and their integration in GIS.
- Explain the Spatial Analysis and Modelling in GIS platform.
- Provide an insight about map transportation related to environment and hazards.

Course Outcomes: At the end of the course, the student is expected to be able to:

- Develop GIS-T Data Models.
- Understand the basic concepts in context of GIS data models in transportation data capture.
- Represent Transportation Data in GIS Environment
- Analyse and model spatial and transportation facilities in GIS.
- Understand how GIS processes can be used for efficient transportation modeling and analysis.
- Map transportation related environmental pollutants, accidents in GIS platform.

Mapping of Course Outcomes with programme Outcomes:

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TKS231	CO1	3		3									2	2	1
	CO2	3	3	3									3	2	1
	CO3	3	3	3		2				2	2		3	2	2
	CO4		3		2	2	2			2	2	2	2	3	2
	CO5	3	3	3									3	2	1
	CO6	3	3	3		2				2	2		3	2	2

Weightage distribution for Assessment:

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4

CO6		**5**	**3**	**8**	**16**	**Level-5**
Total Marks	**15**	**15**	**20**	**50**	**100**	
	6th Week	**12th Week**	**14th Week**	**17th-20th Week**		

Course Contents:

Unit-1 12 hours

GIS Concepts and Data Models: Geospatial data, Sources, Methods of collection, Evolution of Digital Mapping, Attribute Data, Data formats and Collection methods; Introduction and Concepts of GIS; Data Domains and Data Modelling in GIS; Data Modelling Techniques.

Unit-2 12 hours

Transportation Data Sources and Integration: Basic Mapping Concepts; Transportation Data Capture and Data Products; Transportation Data Integration; Spatial Data Quality; Spatial and Network aggregation. **Shortest Path and Routing:** Fundamental Network Properties; Fundamental Properties of Algorithms; Shortest Path Algorithms; Routing Vehicles with in Networks.

Unit-3 12 hours

GIS Based Spatial Analysis and Modelling: GIS and spatial Analysis; Urban sprawl; GIS Analytical functions; Coupling Transportation Analysis and Modelling with GIS; Customising GIS; Supporting Advanced Transportation Analysis in GIS.

Unit-4 12 hours

Transportation, Environment and Hazards: Mapping sensitive Environmental features; GIS and Transportation related Air Quality; Accidents and Safety Analysis; Transportation of hazardous Materials.

Readings and References:

1. Alan Paul Vonderohe, Alan Travis, and Robert Smith. Implementation of Geographic Information Systems (GIS) in State DOTs: An NCHRP Digest of the Essential Findings from the Interim Report on NCHRP Project 20-27 'Adaptation of Geographic Information Systems for Transportation', *Issue 180 of Research results digest*, TRB, 1991.
2. Chor Pang Lo, Albert K.W. Yeung - *Concepts and Techniques of Geographic Information Systems*, 2nd Edition, Prentice Hall, 2006.
3. Henk J. Scholten and John Stillwell, Geographical Information Systems for Urban and Regional Planning, Springer, 2010.
4. Miller HJ and Shaw SL, Geographic Information Systems for Transportation (GIS –T): Principles and Applications, Oxford University Press, 2001

5. NCHRP Synthesis 446. Use of Advanced Geospatial Data, Tools, Technologies, and Information in Department of Transportation Projects: A Synthesis of Highway Practice, TRB 2013.
6. Simlowitz HJ. GIS Support Transportation System Planning, International GIS Sources Book
7. TCRP Synthesis 55. Geographic Information Systems Applications in Transit: A Synthesis of Transit Practice, TRB, 2004.
8. Thill JC, GIS in Transportation, Transportation Research Part C, 2000.

Course code	Course Title	Duration		L	T	P	C
M20TKS232	Land use and Transportation planning	16 Weeks	SC	2	1	0	3
Internal assessment: 50 Marks		Semester End Exam: 50 Marks (Minimum 20 Marks)					

Course Prerequisite: Urban Transport Planning

Course Learning Objectives: Student will be able to learn

- Outline the urban forms, structures and urban planning approach for smart cities.
- Explain the different land use models.
- Provide an insight about transit oriented development concept.
- Explain the different land use and transportation models.

Course Outcomes: At the end of the course, the student is expected to be able to:

- Differentiate different urban forms and urban structures
- Aanalyse and appreciate compact and smart city principles.
- Develop different land use models
- Develop transit oriented development plans for a city
- Examine land use and transportation interaction
- Develop land use and transportation models.

Mapping of Course Outcomes with programme Outcomes:

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TKS232	CO1	2	2		2	3		2					1	2	1
	CO2	2	2		2	3		2				3	1	1	2
	CO3	2				2		3					1	2	1
	CO4	2	3	2		3		3				2	1	2	2
	CO5	2	3	2		3		3				2	1	2	2
	CO6	3	1			2		2					1	2	2

Weightage distribution for Assessment:

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4
CO6		5	3	8	16	Level-5
Total Marks	15	15	20	50	100	
	6^{th} Week	12^{th} Week	14^{th} Week	17^{th}-20^{th} Week		

Course Contents:

Unit-1 12 hours

Urban Forms and Structures: Urbanisation and Migration, Findings of Commission on Urbanisation, Urban forms: Garden City, Linear city etc., Urban structures: Centripetal type, Grid type etc., Evolution of spatial structure. **Compact Cities – Smart Cities:** Urban Planning Approach: Green city, Compact City and Smart City.

Unit-2 12 hours

Land Use Planning: Concentric urban land use model, Sector land use model, multiple nuclei land use model, hybrid land use models, Cellular automata models, and land rent theory; Urban regions.

Unit-3 12 hours

Transit Oriented Development: Transit Oriented Development: Characteristics, Components, Benefits; Policy and Guidelines, TOD Typology, Implementation Strategies, Challenges, Development and Control Norms.

Unit-4 12 hours

Land use – Transportation Models: Land use – Transportation Interactions; Classification of LUT Models, Economic Base Mechanism, Allocation Mechanism and Spatial Allocation and Employment Relationships, Garin Lowry Models.

Readings and References:

1. C. Jotin Khisty and B. Kent Lall, Transportation Engineering: An Introduction, 3rd Edition, Pearson, 2016.
2. C.B. Schoeman, Land Use Management and Transportation Planning, WIT Press, 2015
3. C.S. Papacostas and P.D. Prevedouros, Transportation Engineering and Planning, Third Edition, Prentice Hall of India Pvt. Ltd., 2015.

4. Juan de Dios Ortuzar and Luis G. Willumsen, *Modelling Transport, 4th Edition*, John Wiley and Sons, 2011.
5. Michael D. Meyer, Transportation Planning Handbook, Fourth Edition, Institute of Transportation Engineers, John Wiley & Sons Inc., 2016
6. Stephen Marshall and David Banister, Land Use and Transport: European Research Towards Integrated Policies, Emerald Publishing, 2007 .

Course code	Course Title	Duration		L	T	P	C
M20TKS241	Environmental Impact of Transportation	16 Weeks	SC	2	1	0	3
Internal assessment: 50 Marks		Semester End Exam: 50 Marks (Minimum 20 Marks)					

Course Prerequisite: None

Course Learning Objectives: Student will be able to learn

- Provide an insight regarding environment and its interaction with human activities.
- Explain the different models for prediction of air and noise pollution.
- Discuss the methodology for conducting the EIA study.
- Explain about Mitigation policies and measures

Course Outcomes: At the end of the course, the student is expected to be able to:

- Examine the effects of transportation systems on the environment.
- Develop a clear understanding on the concept of EIA and EIS.
- Estimate air pollution and noise pollution caused by a transportation system.
- Describe the EIA study and its process.
- Apply suitable methods to carry out a detailed EIA study.
- Describe various mitigation policies and measures.

Mapping of Course Outcomes with programme Outcomes:

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TKS241	CO1			3			2	2	1	1			3		1
	CO2	3		3		2	1		3	2		2	3	2	2
	CO3	3		3	3	2	1			3			3	2	2
	CO4	3		3	3	3		2	3				3		3
	CO5	3		3	3	3		2	3				3		3
	CO6	3		3	2	2	1		3	3	3		3	2	3

Weightage distribution for Assessment:

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4
CO6		5	3	8	16	Level-5
Total Marks	15	15	20	50	100	
	6^{th} Week	12^{th} Week	14^{th} Week	17^{th}-20^{th} Week		

Course Contents:

Unit-1 12 hours

Environment, interaction and attributes: Environment and its interaction with human activities; Air and Noise Pollution due to Transportation; Environmental imbalances – Attributes; Impacts, Indicators and Measurements: Concept of Environmental Impact Assessment (EIA), Environmental Impact Statement (EIS).

Unit-2 12 hours

Prediction of Air & Noise Pollution: Factors affecting air pollution from road traffic, Emission inventory; Dispersion of pollutants; Inverse air quality models; Emission and dispersion models; Driving cycles; Macroscopic and Microscopic modeling at the microscopic level of air pollution from road traffic; Road traffic noise model (RTNM), Calixto model, Acoustical assessment.

Unit-3 12 hours

Environmental Impact Assessment and Statement (EIA & EIS): Objectives of EIA, Advantages and Limitations of EIA; Overview of Methodologies Adhoc, Checklist, Matrix, Network, Overlays, Benefit Cost Analysis, Choosing a Methodology, Review Criteria; IRC Code

Unit-4 12 hours

Mitigation Policies and Measures: Cleaner fuels, Vehicle technology and replacement strategies, Improving fuel efficiency, Encouraging non-motorised and public transport, Taxation on emissions; Noise barriers, Land use planning, Resurfacing roads with low-noise materials, Managing traffic flows, advanced construction methods.

Readings and References:

1. Canter, L.W., Environmental Impact Assessment, McGraw-Hill, New York, 1997
2. David Banister; Transport Policy and Environment, E&FN Spain, 1999

3. Keith W. Little, Environmental Fate and Transport Analysis with Compartment Modeling, CRC Press, Taylor & Francis Group, 2012.
4. Louis Franklin Cohen and Gary Richard McVoy, Environmental Analysis of Transportation Systems, John Wiley & Sons, 1982
5. NCHRP Report 541. Consideration of Environmental Factors in Transportation Systems Planning, TRB, 2005.
6. NCHRP Synthesis 272, Best Management Practices for Environmental Issues Related to Highway and Street Maintenance: A Synthesis of Highway Practice, National Research Council, TRB, 1999.
7. Peter Morris and Riki Therivel, Methods of Environmental Impact Assessment (Natural and Built Environment Series), 3rd Edition, Routledge, 2009
8. TRB Special Report 268. Surface Transportation Environmental Research: A Long-Term Strategy, National Academies Press, 2005
9. World Bank; The Impact of Environmental Assessment – A Review of World Bank Experience, Washington, 1997.

Course code	Course Title	Duration		L	T	P	C
M20TKS242	Highway Economics And Finance	16 Weeks	SC	2	1	0	3
Internal assessment: 50 Marks		Semester End Exam: 50 Marks (Minimum 20 Marks)					

Course Prerequisite: None

Course Learning Objectives: Student will be able to learn

- Explain the basic terminology of economics and its application in transportation
- Define the concept and components involved in economic Analysis
- Explain the estimation of vehicle operating costs and value of travel time saving.
- Explain the method of transportation projects financing

Course Outcomes: At the end of the course, the student is expected to be able to:

- Tell the basic terminologies involved in economics
- Estimate accident cost
- Carry out economic analysis of transportation projects
- Estimate the vehicle operating costs.
- Estimate the value of travel time saving of a particular road.
- Analyse financial aspects of all highway projects.

Mapping of Course Outcomes with programme Outcomes:

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TKS242	CO1			3		2				2		2	3	3	1
	CO2	3	3	2		2	2	1		2	2	3	3	3	1
	CO3	2	2	3	3		2				3	3	3	2	2
	CO4		3		2	1		2	1		3	2	3	2	2
	CO5		3		2	1		2	1		3	2	3	2	2
	CO6	2	3	2		3		3				2	1	2	2

Weightage distribution for Assessment:

COs	IA1 -(15)	IA2 -(15)	Assignment (20)	SEE -(50)	Total Marks	Blooms Level
CO1	5		3	8.5	16.5	Level-3
CO2	5		4	8	17	Level-3
CO3	5		3	8.5	16.5	Level-4
CO4		5	4	8	17	Level-4
CO5		5	3	9	17	Level-4
CO6		5	3	8	16	Level-5
Total Marks	15	15	20	50	100	
	6th Week	12th Week	14th Week	17th-20th Week		

Course Contents:

Unit-1 12 hours

Highway Engineering Economics: Transportation costs - Supply and demand - elasticity of demand; Supply of transport services - Economics of traffic congestion - Pricing policy. Vehicle operating costs: Fuel costs - Maintenance and spares, Depreciation - Crew costs - Value of travel time savings - Accident costs.

Unit-2 12 hours

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

Unit-3 12 hours

Vehicle Operating Costs: Introduction. Road used cost study in India, Components of VOC, factors affecting VOC. Fuel consumption relationship. Spare parts consumption. Maintenance and repairs labour cost, tyre life, lubricants, utilisation and fixed costs.

Value of Travel Time Savings: Introduction. Classes of transport users enjoying travel time savings. Methodology for monetary evaluation of passengers, travel time.

Unit-4 **12 hours**

Traffic Congestion: Congestion as a factor in road traffic, Traffic restraint. Road pricing.

Highway Finance: Financing of road projects - methods – Private Public Partnership (PPP) - Toll collection - Economic viability of Design-Build-Operate-Transfer Schemes – Risk Analysis – Value for Money analysis - Case Studies.

Readings and References:

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

Course code	Course Title	Duration		L	T	P	C
M20TK0203	**Transportation Software Laboratory**	**16 Weeks**	**Practical/HC**	**0**	**0**	**2**	**2**
Internal assessment: 20 Marks		**Semester End Exam: 30 Marks (Minimum 08 Marks)**					

Course Prerequisite: Traffic Engineering

Course Learning Objectives: Student will be able to learn

- Explain the description and presentation of real data
- Explain the testing of hypothesis with a help of different statistical tests
- Provides the knowledge about multiple linear regression and correlation analysis.
- Provide the demo training programs for various software packages.

Course Outcomes: At the end of the course, the student is expected to be able to:

- Perform data analysis and its interpretation using MS Excel and advanced tools and packages.
- Estimate Travel Demand using relevant transportation planning packages.
- Simulate traffic at mid-block as well as at Intersections using microscopic simulation tools.
- Analyze Flexible and Rigid Pavements using relevant software.
- Planning of transportation planning by using the softwares like VISUM & CUBE.
- Analysing statistical distributions using R-Console.

Mapping of Course Outcomes with programme Outcomes

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TK0203	CO1	3	3	2	3		2	2	1	1			3	3	2
	CO2	3	2	3	3	2	1		3	2		2	3	3	1
	CO3	3	3	3	3	2	1			3			3	3	2
	CO4	3	2	3	3	3		2	3				3	3	2
	CO5	3	2	3	3	2	1	2	2	2			3	2	2
	CO6	3	2	2	2	3	2	1		3			3	2	3

Course Contents

PART-1 **8 hours**

1. Presentation of Traffic data using Box Plot.
2. Fitting Speed data to Normal Distribution using MS Excel.
3. Fitting Distribution to Vehicle arrival and headway data.
4. Correlation and Regression analysis of traffic data.
5. Testing of Hypothesis using MS Excel/SPSS.
6. Traffic data analysis using R-Console.
7. Analysing statistical distributions using R-Console.

PART-2 **16 hours**

1. TRANSPORTATION PLANNING PACKAGES

- VISUM
- CUBE

2. TRAFFIC ENGINEERING PACKAGES

- OPEN ROADS
- VISSIM

3. PAVEMENT ENGINEERING PACKAGES

- Ken-layer & Ken-slab
- HDM – IV

Exercises on Usages of the Packages and Mini-Project

Readings and References:

1. Bovas A., N. Nair U., Quality Improvement through Statistical Method, Springer Science & Business Media, 01-Aug-1998.
2. Clifford S., E. S. Park, Laurence R. R., Transportation Statistics and Micro-simulation, CRC Press, Taylor and Francis group, 2011.
3. John C., Software for Data Analysis: Programming with R, Stanford University, Springer, 2008.
4. Robert V. Hogg, and Elliot Tanis and Dale Zimmerman, *Probability and Statistical Inference*, 9th Edition, Pearson, 2014

5. User Manuals of various packages.

Course code	Course Title	Duration		L	T	P	C
M20TK0204	Mini project-II	16 Weeks	Practical	0	0	2	2
Internal assessment: 50 Marks		Semester End Exam: 50 Marks (Minimum 20 Marks)					

Course Prerequisite: None

Course Learning Objectives:

Course Outcomes: At the end of the course, the student is expected to be able to:

- Conceptualize, design and implement solutions for specific problems.
- Communicate the solutions through presentations and technical reports.
- Apply resource managements skills for mini projects.
- Synthesize self-learning, team work and ethics.
- To inculcate innovative thinking and thereby preparing students for main project.
- To provide students hands on experience on, troubleshooting, maintenance, innovation, record keeping, documentation etc

Mapping of Course Outcomes with programme Outcomes

Course Code	POs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
M20TK0204	CO1	2	2	3	3	3			2		3	3	3	2	1
	CO2	2	1	2		3			3	3	3	1	2	2	2
	CO3	3	3	2	2	2	2	3			2	3	2	2	3
	CO4	1	2		2		3	2	2	2	3		2	2	3
	CO5	2	3	3		3	3		2	2	2	3	2	2	2
	CO6	1	2	2	2	3	2	3	3	2	2	3	2	2	2

Course Contents

There is no prescribed syllabus. Students are required to search, collect and review various research articles published in chosen area of research. A student has to select a area for his mini project, based on his/her interest. A student shall be required to submit a mini project report on the research work carried out by him/her and give presentation to the Assessment Committee (AC) in the presence of their classmates. It is mandatory for all the students to attend the presentations of their classmates.

Readings and References:

1. Research Articles / Reports available on Internet
2. Transportation Engineering Journals
3. Transportation Engineering Textbooks and Handbooks

III SEMESTER

Sl. No	Course Code	Title of the Course	Practical /Term Work / Sessions	Pre requisite	Credit Pattern & Credit Value				Contact Hours
					L	T	P	Total	
1	M20TKON01	MOOC/SWAYAM Online Course	OE	BE / B. TECH in Civil Engineering	3	1	0	4	--
2	M20TK0301	Internship with Report	Practical/ Term Work and Viva - Voce		2	0	4	6	--
3	M20TK0302	Project Phase-I	Practical/ Report and Viva -Voce		2	0	4	6	--

1. Students will have to choose an online course offered in MOOC/SWAYAM/COURSERA, this course will enhance additional knowledge studying online course of student's choice.
2. Students have to undergo Internship in reputed companies for a minimum period of three months and gain the field related challenges and make himself/herself industry ready
3. During third semester students will be allotted Supervisor/Guide for carrying out dissertation for the full fourth semester term. Identification of dissertation topic, deciding the objectives and Literature review will be done with the discussion with their supervisor/guide.

IV SEMESTER

Sl. No	Course Code	Title of the Course	Practical /Term Work / Sessions	Pre requisite	Credit Pattern & Credit Value				Contact Hours
					L	T	P	Total	
1	M20TK0401	Technical Seminar With Report	Practical/ Term Work		0	0	4	4	--
2	M20TK0402	Dissertation Phase-II	Practical/ Thesis Submission and Viva-Voce		2	0	6	8	--

1. The student is required to deliver a seminar and submit a report on the latest development in Transportation Engineering
2. Elaborate studies on their dissertation work with regard to experimental/analytical/software based investigations, preparing the dissertation report as per university regulations and publication of a paper in reputed journals.