RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)
RV Vidyaniketan Post, Mysuru Road
Bengaluru – 560059

Scheme and Syllabus of I to IV Semester

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)
in
HIGHWAY TECHNOLOGY

DEPARTMENT OF
CIVIL ENGINEERING

VISION

Leadership in Quality Technical education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work and Innovation

RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)
RV Vidyaniketan Post, Mysore Road
Bengaluru – 560059

Scheme and Syllabus of I to IV Semester

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)
in
HIGHWAY TECHNOLOGY

DEPARTMENT OF
CIVIL ENGINEERING

DEPARTMENT OF
CIVIL ENGINEERING

VISION

Excel in Education, Research and Consultancy in Civil Engineering with Emphasis on Sustainable Development

MISSION

1. Disseminating and integrating the knowledge of Civil Engineering and Allied Fields
2. Enhancing Industry-Institute Interaction leading to Interdisciplinary Research.
3. Imbibing wide-range of Skills in Cutting-Edge Technology for Sustainable Development.
4. Motivate Entrepreneurship and Professional Ethics to serve the Society.

PROGRAMME OUTCOMES (PO)

M.Tech in Highway Technology graduates will be able to:

PO1: Independently carryout research / investigation and development work to solve practical problems related to highway technology

PO2: Write and present a substantial technical report /document in the field of Highway technology

PO3: Demonstrate a degree of mastery over materials, analysis, design, construction, maintenance and management of highways

PO4: Use modern tool for design, analysis and management of highways

PO5: Adopt safe, economical, ethical and sustainable factors in design, construction and management of highways.

PO6: Exhibit multi-disciplinary and management skills with commitment to lifelong learning.

ABBREVIATIONS

Sl. No.	Abbreviation	Acronym
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics
23.	MCA	Master of Computer Applications
24.	MST	Structural Engineering
25.	MHT	Highway Technology
26.	MPD	Product Design & Manufacturing
27.	MCM	Computer Integrated & Manufacturing
28.	MMD	Machine Design
29.	MPE	Power Electronics
30.	MVE	VlSI Design & Embedded Systems
31.	MCS	Communication Systems
32.	MBS	Bio Medical Processing Signal & Instrumentation
33.	MCH	Chemical Engineering
34.	MCE	Computer Science & Engineering
35.	MCN	Computer Network Engineering
36.	MDC	Digital Communication
37.	MRM	Radio Frequency and Microwave Engineering
38.	MSE	Software Engineering
39.	MIT	Information Technology
40.	MBT	Biotechnology
41.	MBI	Bioinformatics

CONTENTS

RV COLLEGE OF ENGINEERING®, BENGALURU - 560059
(Autonomous Institution Affiliated to VTU, Belagavi)

DEPARTMENT OF CIVIL ENGINEERING

M.Tech Program in HIGHWAY TECHNOLOGY

FIRST SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18MAT 11A	Applied Mathematics	Maths	4	0	0	**4**
2	18MHT 12	Pavement Materials	CV	4	0	1	**5**
3	18MHT 13	Traffic Engineering and Design	CV	4	0	1	**5**
4	18HSS 14	Professional Skills Development	HSS	0	0	0	**0**
5	18MHT 1AX	Elective - A	CV	4	0	0	**4**
6	18MHT 1BX	Elective - B	CV	4	0	0	**4**
Total number of Credits				**20**	**0**	**2**	**22**
Total Number of Hours / Week				**20**	**0**	**4**	**24**

SECOND SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18MHT 21	Pavement Analysis and Design	CV	4	0	1	**5**
2	18MHT 22	Highway Construction and Maintenance	CV	4	0	0	**4**
3	18IEM 23	Research Methodology	IEM	3	0	0	**3**
4	18MHT 24	Minor project	CV	0	0	2	**2**
5	18MHT 2CX	Elective -C	CV	4	0	0	**4**
6	18MHT/MST 2DX	Elective -D	CV	4	0	0	**4**
7	18XX2G XX	Elective -G (Global Elective)	Respective boards	3	0	0	**3**
Total number of Credits				**22**	**0**	**3**	**25**
Total Number of Hours / Week				**22**	**0**	**6**	**28**

SEMESTER : I		
GROUP A: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	18MHT 1A1	Soil Mechanics for Highway Engineering
2.	18MHT 1A2	Road Safety Engineering
3.	18MHT 1A3	Infrastructure Finance
GROUP B: PROFESSIONAL ELECTIVES		
1.	18MHT 1B1	Highway Geometric Design
2.	18MHT 1B2	Remote Sensing and GIS in Transportation Planning
3.	18MHT 1B3	Transportation Planning
SEMESTER : II		
GROUP C: PROFESSIONAL ELECTIVES		
1.	18MHT 2C1	Road Projects
2.	18MHT 2C2	Road Construction Equipments
3.	18MHT 2C3	Advanced Traffic Engineering
GROUP D: PROFESSIONAL ELECTIVES		
1.	18MHT 2D1	Special Problems in Road Construction
2.	18MST 2D2	Design of Bridges and Grade Separators
3.	18MHT 2D3	Intelligent Transportation Systems

GROUP E: GLOBAL ELECTIVES				
Sl. No.	**Host Dept**	**Course Code**	**Course Title**	**Credits**
1.	CS	18CS2G01	Business Analytics	03
2.	CV	18CV2G02	Industrial & Occupational Health and Safety	03
3.	IM	18IM2G03	Modelling using Linear Programming	03
4.	IM	18IM2G04	Project Management	03
5.	CH	18CH2G05	Energy Management	03
6.	ME	18ME2G06	Industry 4.0	03
7.	ME	18ME2G07	Advanced Materials	03
8.	CHY	18CHY2G08	Composite Materials Science and Engineering	03
9.	PHY	18PHY2G09	Physics of Materials	03
10.	MAT	18MAT2G10	Advanced Statistical Methods	03

RV COLLEGE OF ENGINEERING®, BENGALURU - 560059
(Autonomous Institution Affiliated to VTU, Belagavi)

DEPARTMENT OF CIVIL ENGINEERING

M.Tech Program in HIGHWAY TECHNOLOGY

THIRD SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18MHT31	Pavement Deterioration and Evaluation	CV	4	0	1	**5**
2	18MHT32	Internship	CV	0	0	5	**5**
3	18MHT33	Major Project: Phase I	CV	0	0	5	**5**
4	18MHT3EX	Elective-E	CV	4	0	0	**4**
Total number of Credits				**8**	**0**	**11**	**19**
Total Number of Hours/Week				**8**	**0**	**22**	**30**

SEMESTER : III		
GROUP E: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1	18MHT 3E1	Pavement Management Systems.
2	18MHT 3E2	Environment Impact Assessment of Road Projects
3	18MHT 3E3	Road Construction Planning and Management

FOURTH SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18 MHT41	Major Project: Phase II	CV	0	0	20	**20**
2	18 MHT42	Technical Seminar	CV	0	0	2	**2**
Total number of Credits				**0**	**0**	**22**	**22**
Total Number of Hours / Week				**0**	**0**	**44**	**44**

SEMESTER : I						
APPLIED MATHEMATICS (Theory) (Common to AS, BT, CH, CV, IM, ME)						
Course Code	**:**	**18MAT11A**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**

STATISTICS

Method of least squares, fitting of straight line, linearization of nonlinear laws, curve fitting by polynomials, correlation, coefficient of correlation, lines of regression, Spearman rank correlation.

Unit -II	**10 Hrs**

PROBABILITY DISTRIBUTIONS

Introduction to probability, Random variables-discrete and continuous random variables, important measures and moment generating functions, Standard distributions-Binomial, Exponential, Normal and Gamma distributions.

Unit -III	**11 Hrs**

SYSTEM OF LINEAR EQUATIONS AND EIGEN VALUE PROBLEMS

System of linear equations-LU decomposition and Gauss-Jordan method, Eigen value problems–bounds on eigen values, Power method and Inverse Power method, Eigen values and eigen vectors of real symmetric matrices-Jacobi method.

Unit -IV	**11 Hrs**

NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS

Boundary value problems (BVP's)–finite difference method for linear and nonlinear problems, Shooting method and Galerkin method. Finite differences-implicit and explicit scheme, Finite difference methods for parabolic, elliptic and hyperbolic partial differential equations, Finite element method and simple problems.

Unit -V	**10 Hrs**

CONCEPTS OF ENGINEERING OPTIMIZATION

Engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function and objective function surface. Multivariable optimization with inequality constraints-Kuhn-Tucker conditions, Constraint qualification, Genetic operators, Neural-Network-based Optimization. Optimization of Fuzzy systems.

Course Outcomes

After going through this course the student will be able to:

CO1	Identify and interpret the fundamental concepts of statistics, distributions, linear algebra, differential equations and optimization arising in various fields engineering.
CO2	Apply the knowledge and skills of statistical/numerical/optimization techniques to solve problems of least squares, probability distributions, linear equations, eigen value problems and differential equations.
CO3	Analyze the physical problem to establish statistical/mathematical model and use appropriate method to solve and optimize the solution.
CO4	Distinguish the overall mathematical knowledge gained to demonstrate the problems of least squares, probability distributions, linear equations, eigen value problems, differential equations and optimization arising in practical situations

Reference Books

1	Theory and Problems of probability, Seymour Lipschutz and Marc lars Lipson, 2nd edition, Schaum's Outline Series, ISBN: 0-07-118356-6.
2	Introductory method of numerical analysis, S. S. Sastry, 4th edition, 2009, Prentice-Hall India Pvt.LtdISBN : 81-203-1266-X.

3	Numerical methods for scientific and Engineering computation, M K Jain, S. R. K. Iyengar, R. K. Jain, 6th edition; 2012, New Age International Publishers, ISBN-13: 978-81-224-2001-2.
4	Engineering Optimization Theory and Practice, Singiresu S. Rao, 3rd edition, New Age International (P) Ltd., ISBN: 81-224-1149-5.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I						
PAVEMENT MATERIALS (Theory & Practice)						
Course Code	**:**	**18MHT12**		**CIE Marks**	**:**	**100+50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3Hrs+3Hrs**

Unit – I	**10 Hrs**
Soil – types, source, functions, requirements, properties, tests and specifications for use in various components of road. Soil compaction- factors and methods, Alternate and new materials- characteristics and application in highways	
Unit – II	**10 Hrs**
Aggregates–Natural and Manufactured Aggregates, Tests and specifications on road aggregates for flexible and rigid pavements. Importance of aggregate gradation, shape factors	
Unit – III	**11 Hrs**
Bituminous binders and mixes – different types, properties and uses, physical tests on bitumen, Rheological and pavement performance related properties, Modified binders, requirements of ideal pavement binders, characteristics and applications in road construction, criteria for selection of different binders. Bituminous mixes, types, requirements, properties, tests, Marshall Method of mix design, Criteria and super pave mix design, Additives & Modifiers in Bituminous mixes, problems on mix design.	
Unit – IV	**11 Hrs**
Cement and Cement concrete mixes – requirements, design of mix for CC pavement, use of additives, different types of concrete mixes, IRC specifications & Tests, joint filler and sealer materials, special concrete mixes	
Unit – V	**10 Hrs**
Alternate materials – GGBS, Silica Fumes, construction and demolition waste, flyash, admixture – plasticizers, super plasticizers, retarders, other admixtures.	
Unit – VI (Lab Component)	**2 Hrs/ Week**

1. Tests on materials

i. Penetration on aged binders
ii. Viscosity using rotational viscometer
iii. Elastic recovery
iv. Separation test

2. Tests on mixes

v. Bitumen extraction and gradation
vi. Mix design by Marshall Method for dense bituminous mixes.
vii. Temperature susceptibility and Moisture susceptibility using indirect tensile strength test for bituminous mixes
viii. Indirect tensile repeated load tests

Course Outcomes
After going through this course the student will be able to:

CO1	Explain properties and requirements of materials and mixes used for pavements
CO2	Analyze properties of different materials and mixes used for pavements
CO3	Evaluate suitability of different materials and mixes for pavements.
CO4	Propose suitable materials and mixes for pavements.

Reference Books

1	Hot Mix Asphalt Materials, mixture design and construction, Freddy L Roberts, Prithvi S Kandhal, Brown, E R, Lee, D-Y, Kennedy, T W, 2nd Edition, National Asphalt Pavement Association Research and Education Foundation, Maryland, USA, ISBN-10: 0914313010
2	Soil Mechanics for Road Engineers- Her Majesty's Stationary Office, 1952 Publication, ISBN 10: 0115502785, ISBN 13: 9780115502781

3	Pavement Analysis and Design, Huang, 2004, Pearson Publications, ISBN-13:9780131424739.
4	Highway Hand Book of Highway Engineering, T F Fwa, September 28, 2005, CRC Press, ISBN 9780849319860
5	Specifications for Roads and Bridges Works-MoRTH – V Revision, April 2013, Indian Roads Congress.

Scheme of Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Scheme of Continuous Internal Evaluation (CIE): Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Continuous Internal Evaluation (CIE): Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE): Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER : I						
TRAFFIC ENGINEERING AND DESIGN (Theory & Practice)						
Course Code	**:**	**18MHT13**		**CIE Marks**	**:**	**100+50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 + 3 Hrs**

Unit – I	**11Hrs**

Trafficandroaduser characteristics–humanfactorsincludingreactiontimeandvehicularcharacteristics affecting road design and traffic flow, motor vehicle act

Traffic studies- data collection, analysis and interpretation of results of classified traffic volume, spot speed, speed and delay, origin and destination. Sampling in traffic studies–sampling techniques, sampling theory, accuracy and sample size. Accident characteristics, causes, studies, investigations and analysis of individual accidents, statistical analysis, measures to improve road safety. Problems on above.

Unit – II	**10Hrs**

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

Introduction to Queuing theory: vehicle arrivals, delays at intersections, -Problem.

Unit – III	**10Hrs**

Traffic regulations and control– Regulation on vehicles, drivers and traffic flow, Parking studies,Trafficcontroldevices–Types&objectivesofmarkings,signs,signalsandislands,delineators.

Unit – IV	**11Hrs**

Design of signalized intersections including signal timings as per IRC guidelines. Signal system, use of software. Problems. Design of other types of intersections at grade such as intersections with markings, channelized intersections and traffic rotary. Traffic design of grade separated intersections and interchange facilities.

Unit – V	**10Hrs**

Traffic management techniques – Local area management. Low cost measures. Various types of medium - and long-term traffic demand management & measures and their uses, ITS and its applications.

Environmental Issues– Air and Noise pollution due to road traffic, measurement, control of environmental deterioration. Management of environmental pollution due to road traffic.

UNIT-VI (Lab Component)	**2 Hrs/ week**

Data collection and interpretation: Road Inventory for safety studies, Volume Studies, Speed and Headway Studies, Speed and delay studies, Pedestrian surveys, Parking Surveys. traffic Forecasting.

Course Outcomes
After going through this course the student will be able to:

CO1	Explain traffic, traffic flow characteristics, regulations and management of traffic.
CO2	Analyze traffic, traffic flow characteristics, regulations and management of traffic
CO3	Evaluate traffic characteristics for design and management.
CO4	Design and recommend solutions for traffic problems.

References

1.	"TrafficEngineeringandTransportationPlanning"KadiyaliL.R.,2011, Khanna Publication, New Delhi. ISBN-13:9788174092205.
2.	"Traffic Engineering, Matson TM, Smith WS, Hurd FW, Mcgraw Hill Book Co, NY, USA, ISBN 0131424718
1.	Traffic Flow Theory and Control, Drew DR, Mc Graw Hill Book Co, NY, USA. ISBN-13: 978-0070178311.
2.	"Traffic and Highway Engineering", N J Garber & L A Hoel, 5th Edition, 2015, ISBN-13:9781133605157.

3.	IRC3-1983,9-1972,62-1976,64-1990,65-1976,66-1976,67-2001,69-1977,70-1977,73-1980,79-1981,80-1981,86-1983,92-1985,93-1985,99-1988,102-1988,103-1988,106-1990,110-1996IndianRoadsCongress.

Scheme of Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Scheme of Continuous Internal Evaluation (CIE): Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Continuous Internal Evaluation (CIE): Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE): Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER : I						
PROFESSIONAL SKILL DEVELOPMENT (Common to all Programs)						
Course Code	**:**	**18HSS14**		**CIE Marks**	**:**	**50**
Credits L: T: P	**:**	**0:0:0**		**SEE Marks**	**:**	**Audit Course**
Hours	**:**	**24 L**				

Unit – I	**03 Hrs**
Communication Skills: Basics of Communication, Personal Skills & Presentation Skills – Introduction, Application, Simulation, Attitudinal Development, Self Confidence, SWOC analysis. **Resume Writing:** Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts. Theory and Applications.	
Unit – II	**08 Hrs**
Quantitative Aptitude and Data Analysis: Number Systems, Math Vocabulary, fraction decimals, digit places etc. Simple equations – Linear equations, Elimination Method, Substitution Method, Inequalities. **Reasoning** – a. **Verbal** - Blood Relation, Sense of Direction, Arithmetic & Alphabet. b. **Non- Verbal reasoning** - Visual Sequence, Visual analogy and classification. **Analytical Reasoning** - Single & Multiple comparisons, Linear Sequencing. **Logical Aptitude** - Syllogism, Venn-diagram method, Three statement syllogism, Deductive and inductive reasoning. Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions. **Verbal Analogies/Aptitude** – introduction to different question types – analogies, Grammar review, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving	
Unit – III	**03 Hrs**
Interview Skills: Questions asked & how to handle them, Body language in interview, and Etiquette – Conversational and Professional, Dress code in interview, Professional attire and Grooming, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on Stress Interviews, Technical Interviews, and General HR interviews	
Unit – IV	**03 Hrs**
Interpersonal and Managerial Skills: Optimal co-existence, cultural sensitivity, gender sensitivity; capability and maturity model, decision making ability and analysis for brain storming; Group discussion(Assertiveness) and presentation skills	
Unit – V	**07 Hrs**
Motivation: Self-motivation, group motivation, Behavioral Management, Inspirational and motivational speech with conclusion. (Examples to be cited). **Leadership Skills:** Ethics and Integrity, Goal Setting, leadership ability.	

Course Outcomes
After going through this course the student will be able to:

CO1	Develop professional skill to suit the industry requirement.
CO2	Analyze problems using quantitative and reasoning skills
CO3	Develop leadership and interpersonal working skills.
CO4	Demonstrate verbal communication skills with appropriate body language.

Reference Books

1.	The 7 Habits of Highly Effective People, Stephen R Covey, 2004 Edition, Free Press, ISBN: 0743272455
2.	How to win friends and influence people, Dale Carnegie, 1st Edition, 2016, General Press, ISBN: 9789380914787
3.	Crucial Conversation: Tools for Talking When Stakes are High, Kerry Patterson, Joseph Grenny, Ron Mcmillan 2012 Edition, McGraw-Hill Publication ISBN: 9780071772204
4.	Ethnus, Aptimithra: Best Aptitude Book, 2014 Edition, Tata McGraw Hill ISBN: 9781259058738

Phase	**Activity**
I	After the completion of Unit 1 and Unit 2, students are required to undergo a test set for a total of

	50 marks. The structure of the test will have two parts. Part A will be quiz based, evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
II	Students will have to take up second test after the completion Unit 3, Unit 4 and Unit 5. The structure of the test will have two parts. Part A will be quiz based evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
FINAL CIE COMPUTATION	
Continuous Internal Evaluation for this course will be based on the average of the score attained through the two tests. The CIE score in this course, which is a mandatory requirement for the award of degree, must be greater than 50%. The attendance will be same as other courses.	

SEMESTER : I						
SOIL MECHANICS FOR HIGHWAY ENGINEERS **(Group A: Professional Elective)** **(Theory)**						
Course Code	**:**	**18MHT1A1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hrs**

SiteInvestigation: Planning and exploration Methods of Sampling, SPT, Subsoil investigation, Geophysical methods.
Soil Mechanics applications to Highway Engineering. Index properties, various soil classification systems, HRB classification,

Unit – II	**11Hrs**

Shear strength of soil: Introduction, Importance, Measurements, shear strength of clay, Sand, Elastic properties of soil – Tangent, Secant modulus, Stress – Strain curves, Poisson's ratio, Shear Modulus.
Stability of slopes: Introduction, Types, Different methods of analysis of slopes for Øu=0 & C-Ø soil, Location of most critical circle, Earth dam slopes stability, Taylor's stability number. Effect of Earthquake Force

Unit – III	**10Hrs**

Permeability of soil: Darcy's Law, Validity, Soil-watersystem, Types, Determination of permeability, problems.
Soil Compaction: Theories of compaction, factors affecting compaction, Method of Compaction-Laboratory and Field

Unit – IV	**10Hrs**

Highway Drainage: Importance, Surface drainage, Sub-surface drainage, Design of Surface and subsurface drainage system, Road construction in waterlogged and coastal areas, Landslides–Types, factors and remedial measures.

Unit – V	**11Hrs**

Reinforced Earth structures Definition, Components, Advantages, Types of stability–external, Internal, (No problems), Geotextiles–types, Functions, their uses in road embankments and railway works, otheruses.

Course Outcomes
After going through this course the student will be able to:

CO1	Explain the properties of soil as a highway material.
CO2	Analyze soils for their application in pavements, embankment/cuts.
CO3	Examine the suitability of soil for embankments/cuts and subgrade.
CO4	Design geotechnical solutions for embankments/cuts and subgrade.

Reference Books

1.	"Foundation Engineering", G A Leonards, McGraw-Hill, Kogakusha, 1962, ISBN : 0750908203
2.	"Drainage of Highway and Airfield Pavements" Harry R Cedegren, Wiley; 1 edition, 1974, ISBN-13: 978-0471141815
3.	"Highway Engg", S.K. Khanna, C.E.G. Justo,andVeeraragavan A 10th edition. Nem Chand Bros Rookee ISBN 978-81-85240-72-5
4.	"Soil Mechanics for Road Engineers" – HMSO, London. ISBN 10: 0115502785
5.	"Designing with Geosynthetics", Robert M Koerner, 6th edition, Vol 2, ISBN: 9781465345240, 1465345248, 1986

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I						
ROAD SAFETY ENGINEERING **(Group A: Professional Elective)** **(Theory)**						
Course Code	**:**	**18MHT1A2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hrs**

Introduction to safety

Road accidents, Trends, causes, , Highway safety, human factors, Vehicle factors Road Safety, systems approach to safety, road safety improvement strategies, elements of a road safety plan, Safety Data Needs.

Unit – II	**11Hrs**

Data Collection and analysis

Collision and Condition diagrams, Analysis of Crash Data: Before-after methods in crash analysis, Black Spot Identification & Investigations, Case Studies.

Unit – III	**10Hrs**

Road Safety Audits

Key elements of a road safety audit, Road Safety Audits & Investigations, describe methods for identifying hazardous road locations, Case Studies.

Unit – IV	**10Hrs**

Crash Reconstruction

Concepts of crash reconstruction interpretation of data obtained from the roadway surface, speed for various skid, friction, drag, and acceleration scenarios, variables involved in jump and flip crashes, variables involved in pedestrian crashes, Case Studies.

Unit – V	**11Hrs**

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.

Course Outcomes

After going through this course the student will be able to:

CO1	Explain the various aspects of road safety.
CO2	Identify the factors affecting road safety.
CO3	Examine the engineering factors for safety.
CO4	Recommend and design mitigate measures for safety.

Reference Books

1	Practical Road Safety Auditing, Martin Belcher, Steve Proctor, and Phil Cook, 3rdEdition, 2015, ICE Publishing, USA, ISBN: 9780727760166.
2	Practical Road safety auditing, Belche Mr, Proctor and Cook P,2nd Edition, 2008,Publishers-Thomas Telford Limited, London, ISBN: 9780727735157.
3	Traffic Safety, Leonard Evans, 2004,Science Serving Society of Bloomfield Hills, Michigan, ISBN-10: 0975487108.
4	Observational Before-After Studies in Road Safety, Ezra Hauer, February 1, 1997, Emerald Group Publishing Limited ,ISBN-13: 978-0080430539.
5	Traffic Engineering: Theory and Practice, Louis J. Pignataro, Edmund J. Cantilli, Prentice-Hall, 1973, ISBN (Print), 9780139262203

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I						
INFRASTRUCTURE FINANCE **(Group A: Professional Elective)** **(Theory)**						
Course Code	**:**	**18MHT1A3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**11Hrs**
Introduction- Principle, supply and demand models, equilibrium, sensitivity of travel demand, Elasticities– types, models (Kraft demand model) consumer surplus cost – cost elasticity pricing and subsidy policies, rates of interest, Vehicle operation cost, direct and indirect benefits due to road improvement, Total transportation cost, fixed and variable costs. Road user cost studies in India	
Unit – II	**11Hrs**
Economic analysis- Different methods, determination of annual cost, benefit cost ratio, IRR, FYRR, NPV. Sensitivity of economic analysis, Examples of economic analysis for different types of road improvement measures, pavement options, construction of bypasses and upgrading of intersections. Project priorities, methods of dealing with uncertainties.	
Unit – III	**10Hrs**
Financing of road projects- Methods, Public Private Partnership(PPP), environmental economics, Toll collection, economic viability PPP projects, risk analysis, case studies	
Unit – IV	**10Hrs**
Life cycle cost analysis – Introduction, notation, simple and compound interest, uniform series of payments, uniform continuous cash flow and capitalized cost, discrete compound interest factors.	
Unit – V	**10Hrs**
Application of probability and statistics – Introduction, data analysis and evaluation, sampling, significance testing, regression analysis, queing models.	

Course Outcomes
After going through this course the student will be able to:

CO1	Explain the principles of highway economics and finance.
CO2	Solve the highway projects for varying techno – economical conditions.
CO3	Compare economical and financial feasibility for different alternatives of highway projects.
CO4	Justify techno-economic feasibility of highway projects

Reference Books

1	Transportation Economics, McCarthy, 2001, P ,Blackwell, ISBN: 978-0-631-22180-7.
2	Transportation Engineering an Introduction, JotinChisty.C and Kent Lall,B Prentice – hall of India Private limited, New Delhi, ISBN-81-203-2212-6
3	Manual on economic analysis of highway projects, special publication – 30, New Delhi , 2007, Indian Roads Congress,
4	Manual for road investment decision model, special publication – 38, New Delhi, 1992, Indian Roads Congress,
5	Traffic Engineering and Transportation Planning, L R Kadiyali, Khanna Publishers, New Delhi, 2008, ISBN: 9780471632658. 3

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I						
HIGHWAY GEOMETRIC DESIGN **(Group B: Professional Elective)** **(Theory)**						
Course Code	**:**	**18MHT1B1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**11Hrs**
Introduction: Importance, Factors governing geometric design, route selection, geometric design consistency, capacity of rural and urban roads, **Cross Section Elements:** Right of way and width consideration, roadway, shoulders, kerbs, traffic barriers, medians, service roads, pavement surface characteristics, cross slope,skid resistance, unevenness,	
Unit – II	**10Hrs**
Geometric Design Elements: Sight distances-SSD, ISD, OSD, factors governing sight distances, Design of horizontal alignment-overturning and skidding, super elevation, extra widening, transition curves, Design of vertical alignment – gradient, vertical curves,	
Unit – III	**11Hrs**
Intersection Design: At grade intersections – sight distance consideration and principles of design, Channelization, mini round – about, layout of round – about, Inter – Changes – major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes	
Unit – IV	**10Hrs**
Road way facilities and Road safety Furniture: Pedestrian facilities, busbay, truck lay bays, frontage roads, parking areas, cattle crossings, lighting, toll plazas, operation and maintenance centre, landscaping and tree plantation, Road Safety furniture- signage, markings, road humps, speed calming measures	
Unit – V	**10Hrs**
Geometry of Hill Roads: Classification, width of road land, roadway, carriageway, design speed, sight distances, horizontal alignment, vertical alignment, hairpin bends, passing places, lateral and vertical clearances	

Course Outcomes
After going through this course the student will be able to:

CO1	Explain the geometrical design elements.
CO2	Plan the geometric elements for varying conditions of roads.
CO3	Examine the geometric elements for highway geometric design.
CO4	Judge and propose the geometric element facilities for varying highway conditions.

Reference Books

1.	Highway Engineering, Khanna S.K, Justo CEG, Veeraragavan A, 10th Edition, 2015, ,Khanna Publishers, ISBN: 9788185240800.
2.	A Policy on Geometric Design of Highways and Streets, (The Green Book) 6th Edition, American Association of State Highway and Transportation Officials (AASHTO) Publishers, 2011,ISBN Number: 978-1-56051-508-1.
3.	Geometric design projects for Highways: An Introduction,John G Schoon, 2nd Edition, American Society of Civil Engineers Press, ISBN: 978-0-7844-7042-8, 2000.
4.	Relevant Indian Roads Congress Code Books(IRC) IRC011-1962,IRC012-2009,IRC032-1969,IRC064-1990,IRC066-1976,IRC073-1990,IRC080-1981,IRC086-1983,ITC092-1985,IRCSP023-1993,IRCSP99 2013.Publisher Indian Roads Congress, New Delhi.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I						
REMOTE SENSING AND GIS IN TRANSPORT PLANNING **(Group B: Professional Elective)** **(Theory)**						
Course Code	**:**	**18MHT1B2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**11Hrs**
Introduction to remote sensing: Definition – Components of Remote Sensing – Energy, Sensor, Interacting Body –Active and Passive Remote Sensing – Platforms – Aerial and Space Platforms –Balloons, Helicopters, Aircraft and Satellites – Electromagnetic Radiation – EMR Spectrum	
Unit – II	**10Hrs**
Introduction to GIS: Basic Concept and Components – Hardware, Software – Data Spatial and non-spatial –Geo-referencing – Map Projection – Types of Projection – Simple Analysis – Data retrieval and querying	
Unit – III	**10Hrs**
Data structures and analysis: Database – Raster and Vector data structures – Data storage – Run length, Chain and Block coding – Vector data storage – Topology – GIS Modeling - Raster and Vector data analysis– Buffering and overlaying techniques – Network Analysis – Spatial Analysis	
Unit – IV	**11Hrs**
Basic applications in transportation: Highway and Railway Alignment, location of transport terminals and roadside facilities, bus stops – Route optimization – Bus route rationalization – Accident analysis – Applications of Aerial Photography and Satellite Imageries	
Unit – V	**10Hrs**
Advanced applications: GIS as an integration technology – Integration of G IS, GPS and Remote Sensing Techniques – Advanced Traveller Information System (ATIS) – Automatic Vehicle Location System (AVLS).	

Course Outcomes
After going through this course the student will be able to:

CO1	Choose the remote sensing image from different sensors, resolutions, spatial and temporal scales.
CO2	Explain and to comprehend large tracks of earth surface with less time and cost but more accuracy.
CO3	Communicate to the common man his analysis of different problems developments, benefits by preparing different thematic maps.
CO4	Apply GIS and remote sensing techniques in solving real world transportation problems

Reference Books

1.	Concepts and Techniques of Geographic Information System, Lo C P &Yeung A K W, 2006, Prentice Hall of India, New Delhi,
2.	Remote Sensing and Geographical Information Systems, Anji Reddy M, 2001, B S Publications, Hyderabad,
3.	Principles of Geographical Information System, Burrough P A, 1998, Oxford Publication,
4.	Getting started with Geographical Information Systems, Clarke K ,2002, John Wiley & Sons, New York.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I						
TRANSPORTATION PLANNING **(Group B: Professional Elective)** **(Theory)**						
Course Code	**:**	**18MHT1B3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

UNIT – I	**10Hrs**
Introduction: Elements in urban transit system, NUTP, MPO plan. **Transportation Planning Process:** Landuse transportation planning; Systems approach, integration of transport planning, traffic and land use planning, Corridor Management and Preservation.	
UNIT – II	**11Hrs**
Transportation Surveys: Definition of study area, zoning, various types of surveys and interpretation, travel demand and forecasting. **Trip Generation and Distribution:** Trip generation - regression, category analysis Trip distribution - growth factor, Fratar and Furness methods, calibration of Gravity model, intervening opportunities model, competing Opportunities model, Gravity model.	
UNIT – III	**10Hrs**
Modal Split: Factors affecting modal split; Modal split in transport planning. **Traffic Assignment:** Description of transport network, route choice behaviour. Assignment techniques- All-or-Nothing assignment, multipath traffic assignment, capacity restrained traffic assignment.	
UNIT – IV	**10Hrs**
Evaluation: Identification of corridor; Formulation of plans; Economic Evaluation. **Mass Transit Systems:** capacity, operation and management of Fleet planning and Scheduling.	
UNIT – V	**11Hrs**
Case Studies: Case studies on metropolitan transportation planning, integration of multimodal transport systems, best practices and emerging technologies in transportation planning.	

Course Outcomes
After going through this course the student will be able to:

CO1	Explain planning process for an effective transportation system
CO2	Compare the characteristics of mass transit system and methods of collecting traffic data to propose an effective transport facility
CO3	Calculate zonal trip generation and attraction for inter-zonal trip distribution methods
CO4	Evaluate transport system for assigning travel trips to various routes for effective management and economic sustainability

Reference Books

1.	Traffic Engineering and Transport Planning,L R Kadiyali, Khanna Publishers, ISBN 139788174092205, 2011.
2.	"Urban Transportation: Planning, Operation and Management", Ponnuswamy S, Johnson Victor D ,1st Edition,2012, McGraw Hill Education (India) Private Limited, ISBN- 9781259002731.
3	"Transportation Engineering –An Introduction, JotinKhisty and Kent Lall B, 3rd Indian Edition, 2006, PHI, New Delhi, ISBN-13: 978-0130335609.
4.	"Transportation Engineering and planning", Papacostas, C.A, Prevedouros P D, 3rd Edition,2000, Pearson Education India, ISBN-13: 978-0130814197, 2000.
5	Principles of Urban Transport System Planning, Hutchinson, B.G., McGraw-Hill Inc., US, ISBN-13: 978-0070315396,1974.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
PAVEMENT ANALYSIS AND DESIGN (Theory &Practice)						
Course Code	**:**	**18MHT21**		**CIE Marks**	**:**	**100+50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 + 3 Hrs**

Unit – I	**10Hrs**
Pavements-types, functions, choice, Factors affecting design and performance of flexible and rigid pavements–Pavement design factors, loads–axle load distribution, ESWL,EWL, VDF.	
Unit – II	**10Hrs**
Subgrade support-CBR and plate bearing tests, Resilient Modulus, fatigue tests, permanent deformation, factors affecting design and performance of highway and airport pavements – pavement material Characteristics, climatic, drainage and environmental factors, their effects and evaluation.	
Unit – III	**10Hrs**
Stresses and Deflection/strain in flexible pavements: Application of elastic theory, stresses, deflections/strains in single, two and three and multi – layer system, Applications in pavement design. Visco elastic theory	
Unit – IV	**11Hrs**
Flexible pavement design: Empirical, mechanistic- empirical and theoretical design approaches, principle, advantages and application. Design steps by CBR method as per IRC 2001 and 2012, outline of other common design methods such as AASHTO and Asphalt Institute and Shell methods.	
Unit – V	**11Hrs**
Rigid pavement design: Determination of ESWL, EWL for dual and dual tandem wheel loads in Rigid pavements, General designprinciple,Stressesinrigidpavements,stressesduetowheelloadsandtemperaturevariations,designofcementconcrete pavements as per IRC -58-2015 guidelines, KENSLAB, KENLAYER	
(Lab Component)	**2 Hrs/ Week**
Axle load survey, Transverse distribution studies, commercial vehicle traffic survey, stress analysis, flexible pavement design based on IRC, Shell and AASHTO method, rigid pavement design IRC method	

Course Outcomes
After going through this course the student will be able to:

CO1	Explain parameters and methods of pavement design.
CO2	Analyze the parameters for pavement design
CO3	Select suitable parameters for design of pavements.
CO4	Design flexible and rigid pavements.

Reference Books

1	"Principles of Pavement Design", Yoder and Witczak, (second edition) 1975, -John Wiley and sons Inc, ISBN : 978-81-265-3072-4
2	"Pavement Analysis and Design", Huang, 2004–PearsonPublications, ISBN-13:9780131424739.
3	"Design & Performance of Road Pavements", David Croney, Paul Croney,(Third Edition), 1997, -McGrawhill Book Co. ISBN-13:9780070144514.
4	IRC37-2001, 2012, IRC81-1997,IRC58–2002, 2015.IRC59–1976,IRC101-1988,

Scheme of Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of

the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE); Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER : II						
HIGHWAY CONSTRUCTION AND MAINTENANCE (Theory)						
Course Code	**:**	**18MHT22**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hrs**
Plants and Equipments: Components of pavement structure, functions and requirements, Plants and Equipments: Excavators, graders, compactors, crushers, bituminous hot mix plants, cement concrete mixers, pavers - uses in road construction.	
Unit – II	**11Hrs**
Construction of Subgrade and Subbase: Specifications and steps for construction of subgrade, subbase, quality control tests **Construction of granular layers:** Specifications and steps of construction, WBM, WMM, CRM, quality control tests **Construction of Bituminous Layers:** Different types of bituminous layers, specifications and construction of bituminous layers, quality control tests	
Unit – III	**11Hrs**
Construction of Cement Concrete Pavements: Specifications and steps for construction of DLC, Paving Quality Concrete pavements, quality control tests Specifications and steps for construction of White topping, Interlocking concrete block pavements, quality control tests **Safety during Construction**: Safety aspects during construction and maintenance works, road safety furniture	
Unit – IV	**10Hrs**
Drainage: Assessment of drainage requirements for the road, design of various drainage components, drainage materials, surface and sub-surface drainage system for roads, drainage of urban roads.	
Unit – V	**10Hrs**
Maintenance: Routine and periodic maintenance, preventive and reactive maintenance for drainage and pavements, Preparation of existing pavement for patching, profile correction, special measures to deal with reflection cracks in pavement overlays, requirements for rehabilitation, recycling.	

Course Outcomes

After going through this course the student will be able to:

CO1	Explain the specifications and steps for construction of Embankment, subgrade, subbase, granular, Bituminous and concrete layers
CO2	Select the specifications for construction and maintenance of pavement layers.
CO3	Examine the quality of pavement layers during construction and maintenance.
CO4	Construct and maintain the pavements.

Reference Books

1.	"Specifications for Road and Bridge works", MoRTH, fifth revision, 2013, Indian roads Congress, New Delhi
2.	"Construction Planning, Equipment, and Methods" Robert L.Peurifoy, Clifford J. Schexnayder, AviadShapira, Robert Schmitt, 2013 McGraw-Hill, ISBN-13: 978-0073401126
3.	"Hot Mix Asphalt Materials, Mixture Design and Construction", Freddy L Roberts, Prithvi S kandhal et.al (2nd Edition) National Asphalt Pavement Association, Research and Education Foundation, Maryland, USA , ISBN-10: 0914313010
4.	IRC :15-2011, IRC :14-2004, IRC :35-2015, IRC:67-2012, IRC:109-2015, IRC:111-2009, IRC:120 - 2015, IRC:SP:11-1984, IRC:SP:42-2014, IRC:SP:50-2013, IRC :SP: 6-2004, IRC:SP:68-2005, IRC:SP:76-2015,
5.	"Drainage of Highway and Airfield Pavements" Harry R Cedegren, Wiley; 1 edition, 1974, ISBN-13: 978-0471141815

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
RESEARCH METHODOLOGY (Common to all programs)						
Course Code	**:**	**18IM23**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**

Overview of Research

Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, completely randomized, randomized block, Latin Square, Factorial.

Unit – II	**08 Hrs**

Data and data collection

Overview of probability and data types Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules.

Sampling Methods: Probability sampling and Non-probability sampling

Unit – III	**08 Hrs**

Processing and analysis of Data

Statistical measures of location, spread and shape, Correlation and regression, Hypothesis Testing and ANOVA. Interpretation of output from statistical software tools

Unit – IV	**08 Hrs**

Advanced statistical analyses

Non parametric tests, Introduction to multiple regression, factor analysis, cluster analysis, principal component analysis. Usage and interpretation of output from statistical analysis software tools.

Unit-V	**07 Hrs**

Essentials of Report writing and Ethical issues

Significance of Report Writing , Different Steps in Writing Report, Layout of the Research Report , Ethical issues related to Research, Publishing, Plagiarism

Case studies: Discussion of case studies specific to the domain area of specialization

Course Outcomes

After going through this course the student will be able to:

CO1	Explain the principles and concepts of research types, data types and analysis procedures.
CO2	Apply appropriate method for data collection and analyze the data using statistical principles.
CO3	Present research output in a structured report as per the technical and ethical standards.
CO4	Create research design for a given engineering and management problem situation.

Reference Books:

1	Research Methodology Methods and techniques by, Kothari C.R., New Age International Publishers, 4th edition, ISBN: 978-93-86649-22-5
2	Management Research Methodology, Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Pearson Education: New Delhi, 2006. ISBN: 978-81-77585-63-6
3	The Research Methods Knowledge Base, William M. K. Trochim, James P. Donnelly, 3rd Edition, Atomic Dog Publishing, 2006. ISBN: 978-1592602919
4	Statistics for Management, Levin, R.I. and Rubin, D.S., 7th Edition, Pearson Education: New Delhi.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
MINOR PROJECT						
Course Code	**:**	**18MCE24**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**0:0:2**		**SEE Marks**	**:**	**100**
Hours/Week	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. Each project group will consist of maximum of two students.
2. Each student / group has to select a contemporary topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to four.
5. The minor project would be performed in-house.
6. The implementation of the project must be preferably carried out using the resources available in the department/college.

Course Outcomes: After completing the course, the students will be able to

CO1	Conceptualize, design and implement solutions for specific problems.
CO2	Communicate the solutions through presentations and technical reports.
CO3	Apply resource managements skills for projects.
CO4	Synthesize self-learning, team work and ethics.

Scheme of Continuous Internal Examination

Evaluation will be carried out in 3 phases. The evaluation committee will comprise of 4 members: Guide, Two Senior Faculty Members and Head of the Department.

Phase	Activity	Weightage
I	Synopsys submission, Preliminary seminar for the approval of selected topic and objectives formulation	20%
II	Mid term seminar to review the progress of the work and documentation	40%
III	Oral presentation, demonstration and submission of project report	40%

** Phase wise rubrics to be prepared by the respective departments

CIE Evaluation shall be done with weightage / distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/ experimental setup 25%
- Conducting experiments/ implementation / testing 25%
- Demonstration & Presentation 15%
- Report writing 25%

Scheme of Semester End Examination (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

- Brief write up about the project 05%
- Presentation / Demonstration of the Project 20%
- Methodology and Experimental results & Discussion 25%
- Report 20%
- Viva Voce 30%

SEMESTER : II						
ROAD PROJECTS **(Group C: Professional Elective)** **(Theory)**						
Course Code	**:**	**18MHT2C1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hrs**
Road Project Reports: Salient features of ongoing road projects in India, Objects and Scope of Prefeasibility, feasibility and detailed project report for road projects, typical HR structure for preparation of project reports and implementation of road projects, key acts related road projects	
Unit – II	**11Hrs**
Surveys and Investigations for Road Improvement Projects: Traffic surveys and forecasting, topographical surveys, geotechnical and material surveys, Pavement surveys and investigations, Cross drainage structure and drainage surveys, Interpretation of survey results	
Unit – III	**11Hrs**
Geometric Design and General elements: Geometrical elements of rural and urban roads – cross sectional elements, horizontal and vertical alignment, Intersections-requirements, capacity of roads Road way facilities: pedestrian facilities, bus bays, truck lay byes, traffic, medical and vehicle rescue aid posts, street lighting, Road safety audit, road safety furniture, Mx Roads	
Unit – IV	**10Hrs**
Environmental Impact Assessment: Objectives, procedure of environmental impact assessment, socio economic survey, mitigation measures, Landscaping and tree plantation, implementation of environment management plan, Key environmental legislations, clearances required for road project- environmental, forest, CRZ, wild life, air, noise quality standards	
Unit – V	**10Hrs**
Contract Documents and Tender Evaluation: preparation of BOQ, Types of tender documents, salient clauses of tender document, tender evaluation –technical and financial,	

Course Outcomes
After going through this course the student will be able to:

CO1	Explain the components and need of different types of road project reports.
CO2	Choose and execute various surveys and investigations for the road projects.
CO3	Analyze the surveys and investigations and select geometry of road
CO4	Understand the contract document, evaluation and contract management for road projects

Reference Books

1.	IRC:SP:19-2001 “Manual for Survey, investigation and Preparation of Road Project” 2001, Indian Roads Congress, New Delhi
2.	IRC-73: Guidelines for Geometric Design Standards of Rural Highways, Indian Roads Congress, New Delhi
3	IRC:86: Guidelines for Geometric Design standards of Urban roads, Indian Roads Congress, New Delhi
4.	MoRTH Model Concession Agreement for Small Road Projects-2000, Indian Road Congress, New Delhi
5	Relevant IRC Guidelines

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ROAD CONSTRUCTION EQUIPMENTS **(Group C: Professional Elective)** **(Theory)**						
Course Code	**:**	**18MHT2C2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hrs**
Introduction Importance of plants and equipments – advantages and limitations, types of construction equipment used in road construction,	
Unit – II	**10Hrs**
Equipment for earthwork, hauling and spreading Dozers, excavators, loaders, hauling units, graders – application, types, production, factors effecting the production	
Unit – III	**11Hrs**
Plants for productions of aggregates and mixes Crushers- types, factors effecting the production, Pug mill for production wet mix macadam, Hot bituminous mix plants – types, production process, Concrete batching plant- cement concrete production process	
Unit – IV	**11Hrs**
Paving and Compacting Equipment Pavers – components, types of pavers, factors influencing paving quality, Compactors – types, application, Miscellaneous equipment – Kerb casting equipment, road marking equipment, bitumen sprayers	
Unit – V	**10 Hrs**
Equipment Management Forecasting equipment requirement, maintenance of equipment, selection of construction equipment-task considerations, cost considerations, equipment acquisition options	

Course Outcomes

After going through this course the student will be able to:

CO1	Explain the broad features of road construction equipment
CO2	Select construction equipments for road construction
CO3	Evaluate the productivity of the equipments.
CO4	Optimize equipment productivity for road construction

Reference Books

1	"Construction Planning Equipment and Method", Peurifoy RL and Clifford JS (8th Edition) 2010, McGraw Hill Book Co Inc, ISBN:13:978-0073401126.
2	"Construction Equipment and its Management", SC Sharma 2002, Khanna Publishers, ISBN-13:978-8174091376
3	"Construction project management planning, scheduling and controlling", K KChitkara (Third Edition) June 2014, Tata McGrawhill Publications. ISBN-13: 978-9339205447.
4	IRC SP:96-2012, IRC -97-2013, IRC-SP:86:2010, IRC SP:39-1192

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ADVANCED TRAFFIC ENGINEERING **(Group C: Professional Elective)** **(Theory)**						
Course Code	**:**	**18MHT2C3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**11Hrs**
Traffic flow theory – scope, relationship between flow variables, bottle necks, Problems. Queuing theory and applications; vehicle arrivals, delays at intersections, Elements of simulation technique in traffic Engineering, Problems	
Unit – II	**10Hrs**
Traffic Forecast – objects, factors governing traffic growth, estimation of traffic growth from past trends, econometric models. Common methods of traffic forecast, Problems.	
Unit – III	**11Hrs**
Road accident - causes, scientific investigations and data collection. Analysis of individual accidents to arrive at causes; statistical methods of analysis of accident data, computer analysis. Road safety issues, various measures for road safety - engineering, educational and enforcement measures, Short term and long-term measures. Road safety education and training. Economic evaluation of improvement measures by "before and after studies". Problems.	
Unit – IV	**10Hrs**
Traffic managementtechniques - Local area management. Transportation system management. Low cost measures. Various types of medium and long term traffic management measures and their uses. Evaluation of the effectiveness and benefits of different traffic management measures, Elements of area traffic control and Intelligent transportation systems	
Unit – V	**10Hrs**
Environmental issues – air and noise pollution due to road traffic, measurement, control of environmental deterioration. Management of environmental pollution due to road traffic.	

Course Outcomes **After going through this course the student will be able to:**	
CO1	Explain traffic flow, forecast, accidents, traffic and environment management.
CO2	Analyze trends of traffic flow, forecast, accidents, traffic and environment management
CO3	Evaluate traffic flow, forecast, accidents and environment for traffic management.
CO4	Design and recommend solutions for better traffic management.

Reference Books	
1	"Traffic Engineering & Transport Planning", L.R Kadiyali, - reprint 2004, khanna publishers
2	"Road conditions and Traffic Safety", BabkovV.F. - 1975 - MIR publications.
3	"Safer Roads – A Guide to Road Safety Engg", K.W. Ogden, -Aver bury Technical, 1996 Ashgate Publishing Ltd., Alder shot, England,
4	"Traffic Engineering"- Theory and Practice', Pignataro, Louis, John Wiley.
5	Relevant IRC Codes.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
SPECIAL PROBLEMS IN ROAD CONSTRUCTION (Group D: Professional Elective) (Theory)						
Course Code	**:**	**18MHT2D1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

UNIT – I	**11 Hrs**
Construction of roads in problematic soils and water logged areas Various effective measures for solving the problems, machinery required and method of construction. Control of water table, capillary cut off and seepage flow in road construction. Design and construction of filter drains.	
UNIT – II	**11 Hrs**
Methods of strengthening weak foundation soil – acceleration of consolidation and settlement of compressible embankment foundation using vertical sand drains-application, design and construction method.	
UNIT – III	**10 Hrs**
Problems in construction of high embankments- settlement and stability of embankment, foundation. Stability of hill slopes, control of erosion. Types of Failure of slopes, Methods of analysis of slope stability – Slip Circle and Taylors methods, Total and Effective Stress Methods, Determination of Stresses in Foundation for settlement Analysis, Analysis of Consolidation settlements of Embankments	
UNIT – IV	**10 Hrs**
Use of special materials -geo-synthetics for drainage and in pavement layers. Use of reinforced earth retaining walls, Nailing Technique, Techniques of pavement construction using recycled materials–cold and hot mix recycling of bituminous materials. **Soil stabilization** – Types, materials, design and Construction of various stabilization techniques like lime, cement, bituminous and fly ash.	
UNIT – V	**10 Hrs**
Special construction techniques-construction techniques of cell filled concrete pavements–design, economics and construction method, and its application. Road construction on desert region and coastal areas, alternative methods, road construction on high altitudes, hilly and mountainous terrain.	

Course Outcomes

After going through this course the student will be able to:

CO1	Explain the difficulties of road construction in weak and marshy soils and the precautions to be taken.
CO2	Choose improvement methods of strengthening soil fills and embankments for pavement layers.
CO3	Analyze the difficulties associated with construction of high embankments and maintaining hill slopes stability.
CO4	Evaluate the use of recycled materials in road construction with appropriate design methods, construction methods for roads in coastal and desert environment.

Reference Books

1.	"Designing with Geosynthetics", R.M.Koerner - 4th Edition 1997 Prentice Hall, New Jerssey, ISBN-13: 978-0131454156, ISBN-10: 0131454153
2.	IRC-75 "Guidelines for the design of High embankments" -IRC,1979
3.	DSIR–HMSO,London,1954, ISBN: 9780115502781
4.	"Foundation Engineering", Leonards G.A-McGraw 1962 Hill Book Company, New York, ISBN-10: 0070371989; ISBN-13: 978-0070371989
5.	"Drainage of High wayand Airfield Pavement", CedgreenH.R. 1974 –John WilleyandSons. Inc, New York, ISBN : 1560512636
6.	"Pavements on Expansive clays", G.KassiffM.Livnet.G.Wisemen, 1969 –Jerusalem Academy Press, Jerusalem. Israel.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
DESIGN OF BRIDGES AND GRADE SEPARATORS **(Group D: Professional Elective)** **(Theory)**						
Course Code	**:**	**18MHT2D2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

UNIT – I	**10 Hours**
Introduction: Historical Developments, Site Selection for Bridges, Classification of Bridges and Forces on Bridges. Bridge substructures: Abutments, Wing walls, Approaches.	
. UNIT – II	**11 Hours**
Box Culvert: Different Loading Cases IRC Class AA Tracked, Wheeled and Class A Loading, working out the worst combination of loading, Moment Distribution, Calculation of BM & SF, Structural Design of Slab Culvert, with Reinforcement Details.	
UNIT-III	**11 Hours**
T Beam Bridge Slab Design: Proportioning of Components Analysis of interior Slab & Cantilever Slab Using IRC Class AA Tracked, Wheeled Class A Loading, Structural Design of Slab, with Reinforcement Detail. T Beam Bridge Cross Girder Design: Analysis of Cross Girder for Dead Load & Live Load Using IRC Class AA Tracked, Wheeled Class A Loading A Loads, Structural Design of beam with Reinforcement Detail.	
UNIT – IV	**10 Hours**
Bearings – Types of bearings, Bearings for slab bridges – Bearings for girder bridges – Design of Elastomeric bearing – Joints – Expansion joints, repair and rehabilitation of concrete bridges.	
UNIT – V	**10Hours**
PSC Bridges: Introduction to Pre and Post Tensioning, Proportioning of Components, Analysis and Structural Designof Slab, Analysis of Main Girder using COURBON's Method for IRC Class AA tracked vehicle, Calculation of pre-stressing force and eccentricity, cable profile and calculation of stresses, Design of End block and detailing of main girder.	

Course Outcomes
After going through this course the student will be able to:

CO1	Explain the components of a bridge following the specifications for highways.
CO2	Compare different types of bridge bearings, their installation and maintenance aspects under the action of vehicular loads.
CO3	Analyse the IRC loading conditions for the design of bridges.
CO4	Evaluate the design aspects of bridge approaches for RCC, PSC and Steel bridges.

Reference Books

1.	"Essentials of bridge Engineering", D.Johnson Victor,-Oxford, IBH publishing company, ISBN, 8120417178, 9788120417175
2.	"Bridge Engineering", Ponnuswamy-,1989, McGraw Hill Publication, ISBN-10: 0070656959
3.	"Design of Concrete Bridges", VaziraniRatwani&M.G.Aswani, 2004 –KhannaPublishers, New Delhi, ISBN-13. 978-81-7409-117-3. ISBN-10
4.	"Design of Bridges"- Dr. Krishna Raju, Oxford, 2001 IBH Publishing company Limited, ISBN978-81-204-1741-0 788120 114 17410

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
INTELLIGENT TRANSPORTATION SYSTEMS **(Group D: Professional Elective)** **(Theory)**						
Course Code	**:**	**18MCE2D3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
History of ITS: – Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS technological elements, Definitions/Functions, Purpose.	
Unit – II	**11Hrs**
Design and implementation: Selection of methodologies, data collection and processing, control, decision systems, simulation, real-time systems, car for the future, intelligent vehicle sensor technologies, microcontrollers and micro-electronic technology, vehicle optical sensor, radio frequency technologies for vehicle information systems, global positioning technology, intelligent vehicle detection and control technologies, Case Studies.	
Unit – III	**11Hrs**
ITS functional areas: 1. Advanced traffic management systems (ATMS); 2. Advanced traveller information systems (ATIS); 3. Commercial vehicle operations (CVO); 4. Advanced public transportation systems (APTS); 5. Advanced rural transportation systems (ARTS); 6. Advanced vehicle control systems (AVCS), Case Studies.	
Unit – IV	**10Hrs**
ITS User Needs and Services: Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management	
Unit – V	**10Hrs**
ITS Standards and Applications: ITS architecture and standards -Automated Highway Systems - Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.	

Course Outcomes
After going through this course the student will be able to:

CO1	Select appropriate ITS technology depending upon site specific conditions.
CO2	Design and implement ITS components
CO3	Differentiate different ITS user services
CO4	Understand ITS architecture and standards

Reference Books

1	"Fundamentals of Intelligent Transportation Systems Planning", Choudury M A and Sadek A, (31 March 2003); Artech House publishers,ISBN-10: 1580531601
2	"Intelligent Transport Systems: Technologies and Applications", AsierPerallos, Unai Hernandez-Jayo, Enrique Onieva, ©2015, Ignacio Julio GarcíaZuazola Wiley Publishing, ISBN:1118894782 9781118894781
3	ITS Hand Book 2000 Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
4	"Intelligent Transport Systems", Dominique Luzeaux ,Jean-René Ruault, Michel Chavret 7 MAR 2013 Copyright © 2010 by John Wiley & Sons, Inc DOI: 10.1002/9781118557495.ch6
5	"Perspective on Intelligent Transport Systems", Sussman, J. M, 2005 Artech House Publishers, ISBN-13: 978-0387232577.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
BUSINESS ANALYTICS (Global Elective-G01)						
Course Code	**:**	**18CS2G01**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **08 Hrs**

Business analytics

Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling.

Unit – II **08 Hrs**

Trendiness and Regression Analysis

Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Unit – III **08 Hrs**

Organization Structures of Business analytics

Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, Predictive Analytics, Predicative Modelling, Predictive analytics analysis.

Unit – IV **08 Hrs**

Forecasting Techniques

Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Unit –V **07 Hrs**

Decision Analysis

Formulating Decision Problems, Decision Strategies with and without Outcome, Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Course Outcomes

After going through this course the student will be able to:

CO1	Explore the concepts, data and models for Business Analytics.
CO2	Analyze various techniques for modelling and prediction.
CO3	Design the clear and actionable insights by translating data.
CO4	Formulate decision problems to solve business applications

Reference Books

1	Business analytics Principles, Concepts, and Applications FT Press Analytics, Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, 1st Edition, 2014, ISBN-13: 978-0133989403, ISBN-10: 0133989402
2	The Value of Business Analytics: Identifying the Path to Profitability, Evan Stubs , John Wiley & Sons, ISBN:9781118983881 |DOI:10.1002/9781118983881,1st Edition 2014
3	Business Analytics, James Evans, Pearsons Education 2nd Edition, ISBN-13: 978-0321997821 ISBN-10: 0321997824
4	Predictive Business Analytics Forward Looking Capabilities to Improve Business, Gary Cokins and Lawrence Maisel, Wiley; 1st Edition, 2013.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
INDUSTRIAL AND OCCUPATIONAL HEALTH AND SAFETY (Global Elective-G02)						
Course Code	**:**	**18CV2G02**		**CIE**	**:**	**100 Marks**
Credits L: T: P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

UNIT – I	**7 Hrs**

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and fire fighting, equipment and methods.

UNIT – II	**9 Hrs**

Occupational health and safety: Introduction, Health, Occupational health: definition, Interaction between work and health, Health hazards, workplace, economy and sustainable development, Work as a factor in health promotion. Health protection and promotion Activities in the workplace: National governments, Management, Workers, Workers' representatives and unions, Communities, Occupational health professionals. Potential health hazards: Air contaminants, Chemical hazards, Biological hazards, Physical hazards, Ergonomic hazards, Psychosocial factors, Evaluation of health hazards: Exposure measurement techniques, Interpretation of findings recommended exposure limits. Controlling hazards: Engineering controls, Work practice controls, Administrative controls. Occupational diseases: Definition, Characteristics of occupational diseases, Prevention of occupational diseases.

UNIT – III	**9 Hrs**

Hazardous Materials characteristics and effects on health: Introduction, Chemical Agents, Organic Liquids, Gases, Metals and Metallic Compounds, Particulates and Fibers, Alkalies and Oxidizers, General Manufacturing Materials, Chemical Substitutes, Allergens, Carcinogens, Mutagens, Reproductive Hazards, Sensitizers and Teratogens, Recommended Chemical Exposure Limits. Physical Agents, Noise and Vibration, Temperature and Pressure, Carcinogenicity, Mutagenicity and Teratogenicity. Ergonomic Stresses: Stress-Related Health Incidents, Eyestrain, Repetitive Motion, Lower Back Pain, Video Display Terminals.

UNIT – IV	**7 Hrs**

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT – V	**7 Hrs**

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components,
over hauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps,
iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Course Outcomes
After successful completion of this course the student will be able to:

CO1	Explain the Industrial and Occupational health and safety and its importance.
CO2	Demonstrate the exposure of different materials, occupational environment to which the employee can expose in the industries.
CO3	Characterize the different type materials, with respect to safety and health hazards of it.
CO4	Analyze the different processes with regards to safety and health and the maintenance required in the industries to avoid accidents.

Reference Books	
1.	Maintenance Engineering Handbook, Higgins & Morrow, SBN 10: 0070432015 / ISBN 13: 9780070432017, Published by McGraw-Hill Education. Da Information Services.
2.	H. P. Garg, Maintenance Engineering Principles, Practices & Management, 2009,S. Chand and Company, New Delhi, ISBN:9788121926447
3.	Fundamental Principles of Occupational Health and Safety, Benjamin O. ALLI, Second edition,2008 International Labour Office – Geneva: ILO, ISBN 978-92-2-120454-1
4.	Foundation Engineering Handbook, 2008, Winterkorn, Hans, Chapman & Hall London. ISBN:8788111925428.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
MODELING USING LINEAR PROGRAMMING (Global Elective-G03)						
Course Code	**:**	**18IM2G03**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Linear Programming: Introduction to Linear Programming problem **Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables	
Unit – II	**08 Hrs**
Advanced Linear Programming : Two Phase simplex techniques, Revised simplex method **Duality:** Primal-Dual relationships, Economic interpretation of duality	
Unit – III	**08 Hrs**
Sensitivity Analysis: Graphical sensitivity analysis, Algebraic sensitivity analysis - changes in RHS, Changes in objectives, Post optimal analysis - changes affecting feasibility and optimality	
Unit – IV	**08 Hrs**
Transportation Problem: Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems.	
Unit –V	**07 Hrs**
Assignment Problem: Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP).	

Course Outcomes **After going through this course the student will be able to:**	
CO1	Explain the various Linear Programming models and their areas of application.
CO2	Formulate and solve problems using Linear Programming methods.
CO3	Develop models for real life problems using Linear Programming techniques.
CO4	Analyze solutions obtained through Linear Programming techniques.

Reference Books	
1	Operation Research An Introduction, Taha H A, 8th Edition, 2009, PHI, ISBN: 0130488089.
2	Principles of Operations Research – Theory and Practice, Philips, Ravindran and Solberg - John 2nd Edition, 2000, Wiley & Sons (Asia) Pvt Ltd, ISBN 13: 978-81-265-1256-0
3	Introduction to Operation Research, Hiller, Liberman, Nag, Basu, 9th Edition, 2012, Tata McGraw Hill ISBN 13: 978-0-07-133346-7
4	Operations Research Theory and Application, J K Sharma, 4th Edition, 2009, Pearson Education Pvt Ltd, ISBN 13: 978-0-23-063885-3.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.

Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
PROJECT MANAGEMENT (Global Elective-G04)						
Course Code	**:**	**18IM2G04**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Introduction: Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS), Introduction to Agile Methodology.	
Unit – II	**08 Hrs**
Capital Budgeting: Capital Investments: Importance and Difficulties, phases of capital budgeting, levels of decision making, facets of project analysis, feasibility study – a schematic diagram, objectives of capital budgeting	
Unit – III	**08 Hrs**
Project Costing: Cost of Project, Means of Finance, Cost of Production, Working Capital Requirement and its Financing, Profitability Projections, Projected Cash Flow Statement, Projected Balance Sheet, Multi-year Projections, Financial Modeling, Social Cost Benefit Analysis	
Unit – IV	**08Hrs**
Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Critical Path Method (CPM), Computerized project management	
Unit-V	**07 Hrs**
Project Management and Certification: An introduction to SEI, CMMI and project management institute USA – importance of the same for the industry and practitioners. PMBOK 6 - Introduction to Agile Methodology, Themes / Epics / Stories, Implementing Agile. **Domain Specific Case Studies on Project Management:** Case studies covering project planning, scheduling, use of tools & techniques, performance measurement.	

Course Outcomes
After going through this course the student will be able to:

CO1	Explain project planning activities that accurately forecast project costs, timelines, and quality.
CO2	Evaluate the budget and cost analysis of project feasibility.
CO3	Analyze the concepts, tools and techniques for managing projects.
CO4	Illustrate project management practices to meet the needs of Domain specific stakeholders from multiple sectors of the economy (i.e. consulting, government, arts, media, and charity organizations).

Reference Books

1	Project Planning Analysis Selection Financing Implementation & Review, Prasanna Chandra, 8th Edition, 2010, Tata McGraw Hill Publication, ISBN 0-07-007793-2.
2	A Guide to the Project Management Body of Knowledge (PMBOK Guide), Project Management Institute, 5th Edition, 2013, ISBN: 978-1-935589-67-9
3	Project Management A System approach to Planning Scheduling & Controlling, Harold Kerzner, 11th Edition, 2013, John Wiley & Sons Inc., ISBN 978-1-118-02227-6.
4	Project Management – Planning and Controlling Techniques, Rory Burke, 4th Edition, 2004, John Wiley & Sons, ISBN: 9812-53-121-1

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ENERGY MANAGEMENT (Global Elective-G05)						
Course Code	**:**	**18CH2G05**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	**08 Hrs**
Energy conservation: Principles of energy conservation, Energy audit and types of energy audit, Energy conservation approaches, Cogeneration and types of cogeneration, Heat Exchangers and classification.	
Unit-II	**08 Hrs**
Wet Biomass Gasifiers: Introduction, Classification of feedstock for biogas generation, Biomass conversion technologies: Wet and dry processes, Photosynthesis, Biogas generation, Factors affecting bio-digestion, Classification of biogas plants, Floating drum plant and fixed dome plant their advantages and disadvantages	
Unit –III	**08 Hrs**
Dry Biomass Gasifiers : Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems: Construction and operation of up draught and down draught gasifiers.	
Unit –IV	**08Hrs**
Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, Types of solar cells and fabrication. **Wind Energy:** Classification, Factors influencing wind, WECS & classification.	
Unit –V	**07 Hrs**
Alternative liquid fuels: Introduction, Ethanol production: Raw materials, Pre-treatment, Conversion processes with detailed flow sheet. Gasification of wood: Detailed process, Gas purification and shift conversion, Biofuel from water hyacinth.	

Course Outcomes
After successful completion of this course the student will be able to:

CO1	Understand the use alternate fuels for energy conversion
CO2	Develop a scheme for energy audit
CO3	Evaluate the factors affecting biomass energy conversion
CO4	Design a biogas plant for wet and dry feed

Reference Books

1	Nonconventional energy, Ashok V Desai, 5th Edition, 2011, New Age International (P) Limited, ISBN 13: 9788122402070.
2	Biogas Technology - A Practical Hand Book, Khandelwal K C and Mahdi S S, Vol. I & II, 1986, McGraw-Hill Education, ISBN-13: 978-0074517239.
3	Biomass Conversion and Technology, Charles Y Wereko-Brobby and Essel B Hagan, 1st Edition, 1996, John Wiley & Sons, ISBN-13: 978-0471962465.
4	Solar Photovoltaics: Fundamental Applications and Technologies, C. S. Solanki, 2nd Edition, 2009, Prentice Hall of India, ISBN: 9788120343863.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
INDUSTRY 4.0 (Global Elective-G06)						
Course Code	**:**	**18ME2G06**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Introduction: Industrial, Internet, Case studies, Cloud and Fog, M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework (IIAF), Data Management.	
Unit – II	**08 Hrs**
The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.	
Unit – III	**08 Hrs**
Data Analytics in Manufacturing: Introduction, Power Consumption in manufacturing, Anomaly Detection in Air Conditioning, Smart Remote Machinery Maintenance Systems with Komatsu, Quality Prediction in Steel Manufacturing. Internet of Things and New Value Proposition, Introduction, Internet of Things Examples, IoTs Value Creation Barriers: Standards, Security and Privacy Concerns. Advances in Robotics in the Era of Industry 4.0, Introduction, Recent Technological Components of Robots, Advanced Sensor Technologies, Artificial Intelligence, Internet of Robotic Things, Cloud Robotics.	
Unit – IV	**08 Hrs**
Additive Manufacturing Technologies and Applications: Introduction, Additive Manufacturing (AM) Technologies, Stereo lithography, 3DP, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, Laser Engineered Net Shaping, Advantages of Additive Manufacturing, Disadvantages of Additive Manufacturing. Advances in Virtual Factory Research and Applications, The State of Art, The Virtual Factory Software , Limitations of the Commercial Software	
Unit –V	**08 Hrs**
Augmented Reality: The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardware and Software Technology, Industrial Applications of AR, Maintenance , Assembly, Collaborative Operations , Training. Smart Factories: Introduction, Smart factories in action, Importance, Real world smart factories, The way forward. A Roadmap: Digital Transformation, Transforming Operational Processes, Business Models, Increase Operational Efficiency, Develop New Business Models.	

Course Outcomes
After going through this course the student will be able to:

CO1	Understand the opportunities, challenges brought about by Industry 4.0 for benefits of organizations and individuals
CO2	Analyze the effectiveness of Smart Factories, Smart cities, Smart products and Smart services
CO3	Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits
CO4	Evaluate the effectiveness of Cloud Computing in a networked economy

Reference Books

1	Industry 4.0 the Industrial Internet of Things, Alasdair Gilchrist, Apress Publisher, ISBN-13 (pbk): 978-1-4842-2046-7
2	Industry 4.0: Managing The Digital Transformation, Alp Ustundag, Emre Cevikcan, Springer, 2018 ISBN 978-3-319-57869-9.
3	Designing the industry - Internet of things connecting the physical, digital and virtual worlds, Ovidiu Vermesan and Peer Friess, Rivers Publishers, 2016 ISBN 978-87-93379-81-7

4	The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, Christoph Jan Bartodziej, Springer Gabler, 2017 ISBN 978-3-6581-6502-4.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ADVANCED MATERIALS (Global Elective-G07)						
Course Code	**:**	**18ME2G07**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Classification and Selection of Materials: Classification of materials. Properties required in Engineering materials, Criteria of selection of materials. Requirements / needs of advance materials.	
Unit – II	**08 Hrs**
Non Metallic Materials: Classification of n on metallic materials, Rubber: Properties, processing and applications. Plastics: Thermosetting and Thermoplastics, Applications and properties. Ceramics: Properties and applications. Adhesives: Properties and applications. Optical fibers: Properties and applications. Composites : Properties and applications.	
Unit – III	**08 Hrs**
High Strength Materials: Methods of strengthening of alloys, Materials available for high strength applications, Properties required for high strength materials, Applications of high strength materials	
Unit – IV	**08 Hrs**
Low & High Temperature Materials Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials.	
Unit –V	**08 Hrs**
Nanomaterials: Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials	

Course Outcomes
After going through this course the student will be able to:

CO1	Describe metallic and non metallic materials
CO2	Explain preparation of high strength Materials
CO3	Integrate knowledge of different types of advanced engineering Materials
CO4	Analyse problem and find appropriate solution for use of materials.

Reference Books

1	The Science & Engineering of Materials, Donald R. Askeland, and Pradeep P. Fulay, 5th Edition, Thomson, 2006, ISBN-13-978-0534553968
2	Nanotechnology, Gregory L. Timp, 1999th Editionmm Springer, 1999 ISBN-13: 978-0387983349
3	Material Science and Metallurgy, Dr. VD Kodgire and Dr. S V Kodgire, 42nd Edition 2018, Everest Publishing House ISBN NO: 81 86314 00 8
4	Processing and Fabrication of Advanced Materials, N Bhatnagar, T S Srivatsan, 2008, IK International, ISBN: 978819077702

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
COMPOSITE MATERIALS SCIENCE AND ENGINEERING (Global Elective-08)						
Course Code	**:**	**18CHY2G08**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I — **08 Hrs**

Introduction to composite materials

Fundamentals of composites – need for composites – Enhancement of properties – Classification based on matrix- Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Constituents of composites, Interfaces and Interphases, Distribution of constituents, Types of Reinforcements, Particle reinforced

composites, Fibre reinforced composites. Fiber production techniques for glass, carbon and ceramic fibers Applications of various types of composites.

Unit – II — **08 Hrs**

Polymer matrix composites (PMC)

Polymer resins – Thermosetting resins, Thermoplastic resins & Elastomers,

Reinforcement fibres-Types, Rovings, Woven fabrics. PMC processes – Hand Layup Processes, Spray up processes – Compression Moulding – Injection Moulding – Resin Transfer Moulding – Pultrusion – Filament winding – Injection moulding. Glass fibre and carbon fibre reinforced composites (GFRP & CFRP). Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Mechanical Testing of PMC- Tensile Strength, Flexural Strength, ILSS, Impact Strength- As per ASTM Standard. Applications of PMC in aerospace, automotive industries**.**

Unit -III — **08 Hrs**

Ceramic matrix composites and special composites

Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics

– need for CMC – ceramic matrix – various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – Aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering – Hot pressing – Cold Isostatic Pressing (CIPing) – Hot isostatic pressing (HIPing). Applications of CMC in aerospace, automotive industries- Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol-gel technique- Processing of Ceramic Matrix composites.

Unit –IV — **07 Hrs**

Metal matrix composites

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting, a spray process,

Liquid infiltration In-situ reactions-Interface-measurement of interface properties- applications of MMC in aerospace, automotive industries.

Unit –V — **08 Hrs**

Polymer nano composites

Introduction and Significance of polymer Nano composites. Intercalated And Exfoliated Nanocomposites. Classification of Nano fillers- nanolayers, nanotubes, nanoparticles. Preparation of Polymer Nano composites by Solution, In-situ Polymerization and melt mixing techniques. Characterization Of polymer nanocomposites- XRD, TEM, SEM and AFM. Mechanical and Rheological properties of Polymer Nano composites. Gas barrier,

Chemical-Resistance, Thermal and Flame retardant properties of polymer nanocomposites. Optical properties and Biodegradability studies of Polymer nanocomposites, Applications of polymer nano-composites.	
Course Outcomes **After completing the course, the students will be able to:**	
CO1	Understand the purpose and the ways to develop new materials upon proper combination of known materials.
CO2	Identify the basic constituents of a composite materials and list the choice of materials available
CO3	Will be capable of comparing/evaluating the relative merits of using alternatives for important engineering and other applications.
CO4	Get insight to the possibility of replacing the existing macro materials with nano-materials
Reference Books	
1	Composite Materials Science and Engineering, Krishan K Chawla, 3rd Edition Springer-verlag Gmbh,2012 , ISBN: 978-0387743646
2	The Science and Engineering of Materials, K Balani, Donald R Askeland, 6th Edition- Cengage, Publishers,2013, ISBN: 13: 978-8131516416
3	Polymer Science and Technology, Joel R Fried , 2nd Edition, Prentice Hall, 2014, ISBN: 13: 978-0137039555
4	Nanomaterials and nanocomposites, Rajendra Kumar Goyal , 2nd Edition, CRC Press-Taylor & Francis, 2010, ISBN: 10-9781498761666, 1498761666

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
PHYSICS OF MATERIALS (Global Elective-09)						
Course Code	**:**	**18PHY2G09**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I — **08 Hrs**

Crystal Structure

Discussion of lattice and lattice parameters, seven crystals systems, crystal planes, Miller indices, Interplanar distance, Packing fraction, Structure of different crystals-NaCl and Diamond, Bragg's law, Powder method, Bragg's spectrometer, Qualitative Analysis of Crystal structure using XRD, Reciprocal lattice, Crystal defects-Point, Line, Planar and Volume defects.

Unit – II — **08 Hrs**

Dielectric Materials

Basic concepts, Langevin's Theory of Polarisation, Types of Polarisation, Dipolar relaxation, Frequency Dependence of total polarization (polarizability as a function of frequency), Qualitative discussion of Internal Field and Claussius Mossotti, Dielectric loss spectrum, Dielectric strength, Dielectric Breakdown, Breakdown mechanisms in solid dielectrics, Applications of Solid Insulating materials in capacitors and Liquid insulating materials in Transformers, Dielectric Heating, Piezoelectricity, Direct and Inverse Piezoelectric effect, Coupling factor, spontaneous polarization, Piezolelectricty in Quartz, Various piezoelectric materials- PZT, PVDF, Ferroelectricity, Barium titanate, Poling in Ceramics.

Unit – III — **08 Hrs**

Magnetic Materials

Review of Dia, Para and Ferromagnetic materials, Weiss theory of Ferromagnetism, Hysteresis effect, Magnetostriction, Anti-ferromagnetism, Ferrimagnetsim, Soft and Hard magnetic materials, examples and applications in Transformer cores and Magnetic storage devices, Superconductors, properties, Types of Superconductors, BCS theory, High Temperature Superconductors, Applications in Cryotron and SQUID.

Unit – IV — **07 Hrs**

Semiconducting Materials

Semiconductors-Direct and Indirect band gap semiconductors, Importance of Quantum confinement-quantum wires and dots, size dependent properties, Top down approach, Fabrication process by Milling and Lithography, Bottom up approach, fabrication process by vapour phase expansion and vapor phase condensation, Polymer semi-conductors-Photo conductive polymers, Applications.

Unit –V — **08 Hrs**

Novel Materials

Smart materials-shape memory alloys, Austenite and Martensite phase, Effect of temperature and mechanical load on phase transformation, Pseudoeleasticity, Transformation hysteresis, Superelasticity, Characterization technique-Differntial Scanning calorimetry, Preparation technique- spin coating, Nitinol, CuAlNi alloy and applications.

Biomaterials-Metallic, ceramic and polymer biomaterials, Titanium and Titanium alloys, Carbon nanotubes, Graphene- Properties and Applications.

Course Outcomes

After going through this course the student will be able to:

CO1	Apply the principles of Physics in Engineering.
CO2	Apply the knowledge of Physics for material analysis.
CO3	Identify and Analyze Engineering Problems to achieve practical solutions.
CO4	Develop solutions for Problems associated with Technologies.

Reference Books

1.	Solid State Physics, S O Pillai, 6th Edition, New Age International Publishers, ISBN 10-8122436978.
2.	Introduction to Solid State Physics, C.Kittel, 7th Edition, 2003, John Wiley & Sons, ISBN 9971-51-780

3.	Engineering Physics, Dr.M N Avadhanulu, Dr. P G Kshirsagar, S Chand Publishing, Reprint 2015.
4.	The Science and Engineering of Materials, Askeland, Fulay, Wright, Balanai, 6th Edition, Cengage Learning, ISBN-13:978-0-495-66802-2.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ADVANCED STATISTICAL METHODS (Global Elective-G10)						
Course Code	**:**	**18MAT2G10**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Sampling Techniques: Concepts of random sampling from finite and infinite populations, Simple random sampling (with replacement and without replacement), Sampling distribution of proportions, Expectation and standard error of sample mean and proportion, Sampling distributions of differences and sums.	
Unit – II	**08 Hrs**
Estimation: Point estimation, Estimator and estimate, Criteria for good estimates - unbiasedness, consistency, efficiency and sufficiency, Method of moment's estimation and maximum likelihood estimation, Confidence intervals-population mean (large sample).	
Unit – III	**08 Hrs**
Tests of Hypothesis: Principles of Statistical Inference, Formulation of the problems with examples. Simple and composite hypotheses. Null and alternative hypotheses. Tests - type I and type II error, Testing of mean and variance of normal population (one sample and two samples), Exact and asymptotic tests of proportions. Chi squared test for goodness of fit (Relevant case studies).	
Unit – IV	**07 Hrs**
Linear Statistical Models: Definition of linear model and types, One way ANOVA and two way ANOVA models-one observation per cell, multiple but equal number of observation per cell (Relevant case studies).	
Unit –V	**09 Hrs**
Linear Regression: Simple linear regression, Estimation of parameters, Properties of least square estimators, Estimation of error variance, Multivariate data, Multiple linear regressions, Multiple and partial correlation, Autocorrelation-introduction and plausibility of serial dependence, sources of autocorrelation, Durbin-Watson test for auto correlated variables.	

Course Outcomes
After going through this course the student will be able to:

CO1	Identify and interpret the fundamental concepts of sampling techniques, estimates and types, hypothesis, linear statistical models and linear regression arising in various fields engineering.
CO2	Apply the knowledge and skills of simple random sampling, estimation, null and alternative hypotheses, errors, one way ANOVA, linear and multiple linear regressions.
CO3	Analyse the physical problem to establish statistical/mathematical model and use appropriate statistical methods to solve and optimize the solution.
CO4	Distinguish the overall mathematical knowledge gained to demonstrate the problems of sampling techniques, estimation, tests of hypothesis, regression and statistical model arising in many practical situations.

Reference Books

1.	Fundamentals of Statistics (Vol. I and Vol. II), A. M. Goon, M. K. Gupta and B. Dasgupta, 3rd Edition, 1968, World Press Private Limited, ISBN-13: 978-8187567806.
2.	Applied Statistics and Probability for Engineers, Douglas C. Montgomery and George C. Runger, 6th Edition, John Wiley & Sons, 2014, ISBN:13 9781118539712, ISBN (BRV):9781118645062.
3.	Fundamentals of Mathematical Statistic-A Modern Approach, S.C. Gupta and V.K. Kapoor, 10th Edition, 2000, S Chand Publications, ISBN: 81-7014-791-3.
4.	Regression Analysis: Concepts and Applications, F. A. Graybill and H. K. Iyer, Belmont, Calif, 1994, Duxbury Press, ISBN-13: 978-0534198695.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SYLLABUS
FOR
SEMESTER III & IV

SEMESTER : III						
PAVEMENT DETERIORATION AND EVALUATION (Theory)						
Course Code	**:**	**18MHT31**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:1**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hrs**
Introduction: Structural and functional requirements of flexible and rigid pavements, different types, causes and remedial measures of failures in flexible and rigid pavements.	
Unit – II	**10Hrs**
Pavement surface condition evaluation – requirements, Causes, effects, methods of measurement / evaluation and treatment of: Pavement slipperiness, Riding quality and unevenness, Rating techniques, use of modern equipments for equipment for pavement surface condition measurements, analysis of data, interpretation and application.	
Unit – III	**12Hrs**
Structural evaluation of pavements: requirements, factors affecting structural condition, causes, effects, methods of structural evaluation of flexible pavements by Benkelman beam deflection method, FWD, analysis of data, importance of deflection bowl measurements, interpretation and applications, design of overlay. "Use of FWD and other methods for evaluation of flexible and rigid pavements and their application. Problems	
Unit – IV	**10Hrs**
Overlay design: as per IRC:81-1997, choice of overlay type and pavement materials over existing flexible and rigid pavements, use of white topping, ultra thin white topping, thin white topping and ICBP as overlays	
Unit – V	**10Hrs**
Model pavement studies, pavement testing Under controlled conditions, accelerated testing and evaluation methods. Test track studies. Instrumentation for pavement testing	

(Laboratory Component)

1. Determination of Roughness using fifth wheel bump integrator and MERLIN
2. Pavement distress surveys to evaluate pavement condition through PCI ,PSI and PSR
3. Determination of texture Depth and skid resistance of pavements
4. Structural evaluation of pavements using Benkelman Bump Integrator.

Course Outcomes

After going through this course the students will be able to:

CO1: Explain structural and functional adequacies of flexible and rigid pavements

CO2:Analyze functional and structural deterioration of pavements, overlay types, semifield studies

CO3:Categorize pavement condition, distress and overlay techniques

CO4:Summarize different pavement deterioration and evaluation techniques

Reference Books:

1.	Principles of Pavement Design , E.J. Yoder&Witczak M.W. 2nd Edition – John Willey and Sons Inc., New York, 1975, ISBN: 978-0-471-97780-3
2.	Modern Pavement Management,Hass R., Hudson. W. R., Zaniewisti .J.– Krieger Publishing Company, Florida, 1994, ISBN: 9780070308954
3.	Pavement Analysis, Per Ulitz - Elsevier Amsterdam, ISBN: 0-620-22376-6

4.	Road Deterioration and Maintenance Effects, Models for Planning and Management, William D. O. Paterson, The Highway Design and Maintenance Standards series, A World Bank Publication, June 1990, ISBN-10: 0801835909;ISBN-13: 978-0801835902.
5.	Design and performance of road pavements, David and Paul Croney, 3rd Edition, McGraw hill, 1998, ISBN-10: 0070144516; ISBN-13: 978-0070144514

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : III						
INTERNSHIP						
Course Code	**:**	**18MCE32**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours/week	**:**	**10**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1) The duration of the internship shall be for a period of 8 weeks on full time basis after II semester final exams and before the commencement of III semester.
2) The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.
3) Internship must be related to the field of specialization of the respective PG programme in which the student has enrolled.
4) Students undergoing internship training are advised to report their progress and submit periodic progress reports to their respective guides.
5) Students have to present the internship activities carried out to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final internship report. However, interim or periodic reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry /organizations.
6) The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.
7) The broad format of the internship final report shall be as follows
    - Cover Page
    - Certificate from College
    - Certificate from Industry / Organization
    - Acknowledgement
    - Synopsis
    - Table of Contents
    - Chapter 1 - Profile of the Organization : Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices,
    - Chapter 2 - Activities of the Department
    - Chapter 3 - Tasks Performed : summaries the tasks performed during 8 week period
    - Chapter 4 – Reflections : Highlight specific technical and soft skills that you acquired during internship
    - References & Annexure

Course Outcomes

After going through the internship the student will be able to:

CO1: Apply engineering and management principles
CO2: Analyze real-time problems and suggest alternate solutions
CO3: Communicate effectively and work in teams
CO4: Imbibe the practice of professional ethics and need for lifelong learning.

Scheme of Continuous Internal Evaluation (CIE):

The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor. The committee shall assess the presentation and the progress reports in two reviews.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Explanation of the application of engineering knowledge in industries, ability to comprehend the functioning of the organization/ departments,	45%
Review-II	Importance of resource management, environment and sustainability presentation skills and report writing	55%

Scheme for Semester End Evaluation (SEE):
The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.

SEMESTER : III						
MAJOR PROJECT : PHASE-I						
Course Code	**:**	**18MCE33**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours/week	**:**	**10**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. The Major Project work comprises of Phase-I and Phase-II. Phase-I is to be carried out in third semester and Phase-II in fourth semester.
2. The total duration of the Major project Phase-I shall be for 16 weeks.
3. Major project shall be carried out on individual student basis in his/her respective PG programme specialization. Interdisciplinary projects are also considered.
4. The allocation of the guides shall be preferably in accordance with the expertise of the faculty.
5. The project may be carried out on-campus/industry/organization with prior approval from Internal Guide, Associate Dean and Head of the Department.
6. Students have to complete Major Project Phase-I before starting Major Project Phase-II.
7. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

After going through this course the students will be able to:

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply project and resource managements skills, professional ethics, societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning

Scheme of Continuous Internal Examination (CIE)

Evaluation shall be carried out in two reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Selection of the topic, Literature Survey, Problem Formulation and Objectives	45%
Review-II	Methodology and Report writing	55%

Scheme for Semester End Evaluation (SEE):

Major Project Phase-I evaluation shall be done by an external examiner (domain expert) and respective guide as per the schedule. Maximum of four candidates per batch shall be allowed to take examination. The batches are to be formed based on specific domain of work.

SEMESTER : III						
PAVEMENT MANAGEMENT SYSTEM(Elective E) (Theory)						
Course Code	**:**	**18MHT 3E1**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hours**
Introduction: components and principles of pavement management systems, pavement maintenance measures, planning investment, research management **Pavement performance evaluation:** general concepts, serviceability, pavement distress survey systems, performance evaluation	
Unit – II	**10 Hours**
Pavement Performance Prediction: concepts, modeling techniques, structural condition deterioration models, mechanistic and empirical models, HDM and other models, comparison of different deterioration models. Functional condition deterioration models, unevenness prediction models and other models, comparison. Modeling in rehabilitation, budget planning, problems.	
Unit – III	**11 Hours**
Design alternatives and selection: Design objectives and constraints, basic structural response models, physical design inputs, alternate pavement design strategies and economic evaluation, reliability concepts in pavement engineering, life cycles costing, analysis of alternate pavement strategies based on distress and performance and problems.	
Unit – IV	**11 Hours**
Ranking and optimization methodologies: recent developments, sample size selection, economic optimization of pavement maintenance and rehabilitation. **Expert Systems in Pavement Management:** applications of expert systems for managing pavements, expert system for pavement evaluation and rehabilitation, knowledge-based expert systems.	
Unit – V	**10 Hours**
Implementation and application of Pavement Management Systems.- Introduction-major steps-Maintenance Management. and Scheduling, case studies	

Course Outcomes

After going through this course the student will be able to:

1. CO1: Explain the need of PMS in planning and maintaining the pavements.
2. Analyse the performance of pavements, causes of failure, rating methods.
3. Evaluate the of models for pavement management.
4. Develop the PMS for different levels

Reference Books

1.	Pavement Management System, Ralph Haas and Ronald W. Hudson, McGraw Hill Book Co. 1978, ISBN. 0070253919
2.	Modern Pavement Management Ralph Haas, Ronald Hudson Zanieswki., Kreiger Publications, New York, 1992, ISBN, 0894645889, 9780894645884
3.	Pavement Analysis, Per Ulitz , Elsevier Amsterdam, ISBN: 0-620-22376-6
4.	Proceedings of International Conference on Structural Design of Asphalt Pavements NCHRP, TRR and TRB Special Reports, USA, 2006
5.	Models for Planning and Management The Highway Design and Maintenance, William D. O. Paterson, Standards series, A World Bank Publication, June 1990, ISBN-10: 0801835909;ISBN-13: 978-0801835902.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : III						
ENVIRONMENTAL IMPACT ASSESSMENT OF ROAD PROJECTS(Elective E) (Theory)						
Course Code	**:**	**18MHT 3E2**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hrs**
Introduction: concepts**,** Objectives, approach for environmental impact studies,, socio economic survey, mitigation measures, clearances required for road projects, Flow chart for obtaining environmental clearance, standards – liquid effluents air quality, noise	
Unit – II	**11Hrs**
Environmental and Social Legal Framework: Enforcement agencies-MOEF,CPCB, state pollution control boards, Coastal Management regulatory authority, Central ground water board, key environmental legislations- Environmental act, air acts, forest act, wild life protection act, water acts, coastal zone act, key legislations to road projects-national highways acts, NHAI act, land acquisition act, rehabilitation and resettlement policy, building and construction workers welfare act	
Unit – III	**11Hrs**
Environmental Clearances: General conditions, procedure for obtaining environmental clearances-screening, scoping, public consultation, appraisal, grant or rejection, post environmental clearance monitoring, **Forest and CRZ clearance:** procedure for obtaining clearance forest ,CRZ , wild lifeclearance, other clearances from – state / central water authority, irrigation/ water resources dept, archeological dept, permission for quarrying and borrowing operations,	
Unit – IV	**10Hrs**
Prediction and Assessment – impact on air environment, conceptual approach for addressing air environment impact, prediction approach, identification and incorporation of mitigation measures, Impact of noise, conceptual approach for addressing noise environment impact, impact prediction methods, assessment of significance of impacts, mitigation measures	
Unit – V	**10Hrs**
Socio Economic Assessment : conceptual approach for socio economic impact, traffic impacts, **Evaluation of Alternatives:** Weighing of decision factors, rating / ranking of alternatives, public participation in decision making, techniques for conflict management	

Course Outcomes

After going through this course the student will be able to:

CO1: Explain the Environmental and Social Legal Framework and Environmental Clearances of Road Projects .

CO2: Analyze Impact on Air water and Noise for Road Projects .

CO3: Examine the Prediction and assessment on Environment of Road Projects

CO4: Evaluate Environmental Mitigation measures for Road Projects

Reference Books

1	Environmental impact assessment, Canter, L.W:, McGraw-Hill, 1997
2	Methods of Environmental impact assessment ,Peter Morris & Riki Therivel, Rouledge,2001
3	Environmental Assessment, R K Jain, L V Urban, G S Stacey, H E Balbach, Mc Graw Hill Professional, 2001
4	Highway Impact Assessment, Denver Tolliver, Greenwood publishing group, 1993.
5	IRC SP-1993-2011: Guidelines on Requirements for Environmental clearance of highway projects, Indian Roads Congress, New Delhi

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : III						
ROAD CONSTRUCTION PLANNING AND MANAGEMENT (Elective E) (Theory)						
Course Code	**:**	**18MHT 3E3**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Credits	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hrs**
Project Management Framework: Types and Scope of highway development projects, project management framework, scope and project objectives, project development process, causes of project failure.	
Unit – II	**11Hrs**
Project Scheduling: Project work breakdown, determining activities involved, assessment involved, CPM/ PERT network analysis, work scheduling, methods of work scheduling, factors affecting work scheduling, optimization. overview of MS project, PRIMAVERA.	
Unit – III	**11Hrs**
Resource Planning : human resources, project man power grouping, structuring site organisation, construction materials – provisioning process, inventory management, cost and budget planning	
Unit – IV	**10Hrs**
Construction Equipment: task, cost and engineering considerations,- crushing and mixing plants, rollers, pavers ,equipment acquisition options, selection site for site office, ,	
Unit – V	**10Hrs**
Planning control system: Resource production, scheduling, codification, project management information system, value management.	

Course Outcomes

After going through this course the student will be able to:

1. CO1: Outline broad features of road construction planning and management.
2. Choose appropriate resources for road construction.
3. Evaluate the resources required for road construction.
4.

Propose the planning and management for road construction

Reference Books:

1	Cyber Security Essentials, James Graham, Richard Howard, Ryan Olson CRC Press, 2011 by Taylor and Francis Group. ISBN13: 978-1-4398-5126-5.
2	Cyber security: turning national solutions into international cooperation, James A. Lewis, Volume 25, Number 4, 2003 by center for strategic and international studies, ISBN: 0-89206-426-9.
3	Cyber security: The Essential Body of Knowledge, Dan Shoemaker, Ph.D., William Arthur Conklin, Wm Arthur Conklin, 2012 by cengage learning, ISBN13:978-1-4354-8169-5.
4*	A Survey of Defense Mechanisms Against Distributed Denial of Service (DDoS) Flooding Attacks, S. T. Zargar, J. Joshi and D. Tipper, , in IEEE Communications Surveys & Tutorials, vol. 15, no. 4, pp. 2046-2069, Fourth Quarter 2013.doi: 10.1109/SURV.2013.031413.00127

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt

innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: IV						
MAJOR PROJECT : PHASE-II						
Course Code	**:**	**18MCE41**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:20**		**SEE Marks**	**:**	**100**
Hours/Week	**:**	**40**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. Major Project Phase-II is continuation of Phase-I.
2. The duration of the Phase-II shall be of 16 weeks.
3. The student needs to complete the project work in terms of methodology, algorithm development, experimentation, testing and analysis of results.
4. It is mandatory for the student to present/publish the work in National/International conferences or Journals
5. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

After going through this course the students will be able to:

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply project and resource managements skills, professional ethics, societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning.

Scheme of Continuous Internal Examination (CIE)

Evaluation shall be carried out in three reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Review and refinement of Objectives, Methodology and Implementation	20%
Review-II	Design, Implementation and Testing	40%
Review-III	Experimental Result & Analysis, Conclusions and Future Scope of Work, Report Writing and Paper Publication	40%

Scheme for Semester End Evaluation (SEE):

Major Project Phase-II SEE shall be conducted in two stages. This is initiated after fulfilment of submission of project report and CIE marks.

Stage-1 Report Evaluation

Evaluation of Project Report shall be done by guide and an external examiner.

Stage-2 Project Viva-voce

Major Project Viva-voce examination is conducted after receipt of evaluation reports from guide and external examiner.

Both Stage-1 and Stage-2 evaluations shall be completed as per the evaluation formats.

SEE procedure is as follows:

	Internal Guide	External Examiner	TOTAL	
SEE Report Evaluation	100 marks	100 marks		200 marks
			(A)	(200/2) = 100 marks
Viva-Voce	Jointly evaluated by Internal Guide & External Evaluator		(B)	100 marks
			Total Marks	**[(A)+(B)]/2 = 100**

SEMESTER : IV						
TECHNICAL SEMINAR						
Course Code	**:**	**18MCE42**		**CIE Marks**	**:**	**50**
Credits L:T:P	**:**	**0:0:2**		**SEE Marks**	**:**	**50**
Hours/Week	**:**	**4**		**SEE Duration**	**:**	**30 Mins**

GUIDELINES

1. The presentation shall be done by individual students.
2. The seminar topic shall be in the thrust areas of respective PG programs
3. The seminar topic could be complementary to the major project work
4. The student shall bring out the technological developments with sustainability and societal relevance.
5. Each student must submit both hard and soft copies of the presentation along with the report.
6. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

After going through this course the student will be able to:

CO1: Identify topics that are relevant to the present context of the world
CO2: Perform survey and review relevant information to the field of study.
CO3: Enhance presentation skills and report writing skills.
CO4: Develop alternative solutions which are sustainable.

Scheme of Continuous Internal Evaluation (CIE): Evaluation shall be carried out in two reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Selection of Topic, Review of literature, Technical Relevance, Sustainability and Societal Concerns, Presentation Skills	45%
Review-II	Technological Developments, Key Competitors, Report writing	55%

Scheme for Semester End Evaluation (SEE):

The SEE examination shall be conducted by an external examiner and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.