RV College of Engineering®

Master of Technology (M.Tech)
in
HIGHWAY TECHNOLOGY

Scheme And Syllabus of I - IV Semester (2024 Scheme)

B.E. Programs : AS, BT, CH, CS, CS - AI, CS - CD, CS - CY, CV, EC, EE, ET, IM, IS, ME.
M.Tech (13) MCA, M.Sc. (Engg.)
Ph.D. Programs: All Departments are recognized as Research Centres by VTU Except AI & AS

2024
Edition

99TH
NIRF RANKING IN ENGINEERING (2024)

1501+
Times Higher Education World University Rankings (2024)

601+
Asia University Ranking 2024

EduFuture Excellence Award
Best Private Engineering University (South)
by Zee Digital

1001+
Subject Ranking (Engineering)

801+
Subject Ranking (Computer Science)

IIRF 2024
Engineering Ranking India:
NATIONAL RANK - 07
STATE RANK - 02
ZONE RANK - 04

AAA
Rating in NPTEL Local Chapter (Jan - Apr 2024)
State Ranking -1
National Ranking -16

CURRICULUM STRUCTURE

07 CREDITS PROFESSIONAL CORE COURSE

04 CREDITS BASIC SCIENCE

16 CREDITS INTEGRATED PROFESSIONAL CORE COURSE

24 CREDITS PROJECT WORK

04 CREDITS AEC

19 CREDITS PROFESSIONAL ELECTIVES

06 CREDITS INTERNSHIP

80 CREDITS TOTAL

*ABILITY ENHANCEMENT COURSES (AEC), UNIVERSAL HUMAN VALUES (UHV), INDIAN KNOWLEDGE SYSTEM (IKS), YOGA.

17
Centers of Excellence

11
Centers of Competence

1569
Publications On SCI

440
Publications On Web Of Science

2842
Citations
Last 3 Years

70
Patents Filed

40
Patents Granted
Last 3 Years

61
Published Patents

29
Skill Based Laboratories Across Four Semesters

MOUS: 90+WITH INDUSTRIES / ACADEMIC INSTITUTIONS IN INDIA & ABROAD

₹5 crores
Sponsored Projects

₹14 crores
Consultancy Projects

RV College of Engineering®

Master of Technology (M.Tech)
in
HIGHWAY TECHNOLOGY

Scheme And Syllabus of I - IV Semester (2024 Scheme)

B.E. Programs : AS, BT, CH, CS, CS - AI, CS - CD, CS - CY, CV, EC, EE, ET, IM, IS, ME.
M.Tech (13) MCA, M.Sc. (Engg.)
Ph.D. Programs: All Departments are recognized as Research Centres by VTU Except AI & AS

2024
Edition

Glossary of Abbreviations

1.	AS	Aerospace Engineering
2.	BS	Basic Sciences
3.	BT	Biotechnology
4.	CH	Chemical Engineering
5.	CHY	Chemistry
6.	CIE	Continuous Internal Evaluation
7.	CS	Computer Science & Engineering
8.	CV	Civil Engineering
9.	EC	Electronics & Communication Engineering
10.	EE	Electrical & Electronics Engineering
11.	EI	Electronics & Instrumentation Engineering
12.	ET	Electronics & Telecommunication Engineering
13.	GE	Global Elective
14.	HSS	Humanities and Social Sciences
15.	IM	Industrial Engineering & Management
16.	IS	Information Science & Engineering
17.	L	Laboratory
18.	MA	Mathematics
19.	MBT	M. Tech in Biotechnology
20.	MCE	M. Tech. in Computer Science & Engineering
21.	MCN	M. Tech. in Computer Network Engineering
22.	MCS	M. Tech. in Communication Systems
23.	MDC	M. Tech. in Digital Communication
24.	ME	Mechanical Engineering
25.	MHT	M. Tech. in Highway Technology
26.	MIT	M. Tech. in Information Technology
27.	MMD	M. Tech. in Machine Design
28.	MPD	M. Tech in Product Design & Manufacturing
29.	MPE	M. Tech. in Power Electronics
30.	MSE	M. Tech. in Software Engineering
31.	MST	M. Tech. in Structural Engineering
32.	MVE	M. Tech. in VLSI Design & Embedded Systems
33.	N	Internship
34.	P	Projects (Minor / Major)
35.	PHY	Physics
36.	SDA	Skill Development Activity
37.	SEE	Semester End Examination
38.	T	Theory
39.	TL	Theory Integrated with Laboratory
40.	VTU	Visvesvaraya Technological University

POSTGRADUATE PROGRAMS

Sl. No	Core Department	Program	Code
1.	BT	M. Tech in Biotechnology	MBT
2.	CS	M. Tech in Computer Science & Engineering	MCE
3.	CS	M. Tech in Computer Network Engineering	MCN
4.	CV	M. Tech in Structural Engineering	MST
5.	CV	M. Tech in Highway Technology	MHT
6.	EC	M. Tech in VLSI Design & Embedded Systems	MVE
7.	EC	M. Tech in Communication Systems	MCS
8.	EE	M. Tech in Power Electronics	MPE
9.	ET	M. Tech in Digital Communication	MDC
10.	IS	M. Tech in Software Engineering	MSE
11.	IS	M. Tech in Information Technology	MIT
12.	ME	M. Tech in Product Design & Manufacturing	MPD
13.	ME	M. Tech in Machine Design	MMD
14.	MCA	Master of Computer Applications	MCA

DEPARTMENT VISION

Excel in Education, Research and Consultancy in Civil Engineering with emphasis on Sustainable development.

DEPARTMENT 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

INDEX

HIGHWAY TECHNOLOGY (MHT)												
I SEMESTER												
Sl. No.	Course Code	Sem	Course Title	Credits	Credit Allocation			BoS	Category	CIE Duration(H)	Max Marks CIE	SEE Duration	Max Marks SEE
					L	T	P						
1	MMA211TA	I	Applied Mathematics	**4**	3	1	0	MA	Theory	1.5	100	3	100
2	MHT312IA	I	Pavement Materials **(Theory & Practice)**	**4**	3	0	1	CV	Theory+Lab	1.5	100+50	3	100+50
3	MHT313IA	I	Highway Geometric Design **(Theory & Practice)**	**4**	3	0	1	CV	Theory+Lab	1.5	100+50	3	100+50
4	MXX314AX	I	Professional Core Courses (Cluster Electives) **(Group-A)**	**4**	3	1	0	CV	Theory	1.5	100	3	100
5	MHT415SL	I	Skill Laboratory	**2**	0	0	2	CV	Lab	1.5	50	3	50
6	HSS116EL	I	Technical English	**1**	0	0	1	HSS	Lab (Online)	1.5	50	2	50
II SEMESTER													
7	MHT321IA	II	Pavement Design **(Theory & Practice)**	**4**	3	0	1	CV	Theory+Lab	1.5	100+50	3	100+50
8	MHT322IA	II	Traffic Engineering and Management **(Theory & Practice)**	**4**	3	0	1	CV	Theory+Lab	1.5	100+50	3	100+50
9	MXX323BX	II	Program Specific Courses (Electives) **(Group-B)**	**4**	3	0	0	CV	Theory	1.5	100	3	100
10	MXX324CX	II	Professional Core Courses (Cluster Electives) **(Group-C)**	**4**	3	1	0	CV	Theory	1.5	100	3	100
11	XXX325DX	II	Interdisciplinary Courses (Global Electives) **(Group-D)**	**3**	3	0	0	CV	Theory	1.5	100	3	100
12	MIM426RT	II	Research Methodology (NPTEL)	**2**	2	0	0	IM	NPTEL	***	***	2	50
13	MHT427DL	II	Design Thinking Laboratory	**2**	0	0	2	CV	Lab	1.5	50	3	50
III SEMESTER													
14	MHT331TA	III	Highway Construction and Maintenance	**4**	3	1	0	CV	Theory	1.5	100	3	100
15	MXX332EX	III	Professional Elective Courses (NPTEL) **(Group-E)**	**2**	2	0	0	CV	NPTEL	***	***	2	50
16	MHT433P	III	Minor Project	**6**	0	0	6	CV	Project	***	50	3	50
17	MHT434N	III	Internship	**6**	0	0	6	CV	Internship	***	50	3	50
IV SEMESTER													
18	MXX341FX	IV	Program Specific Courses (NPTEL- Elective) **(Group-F)**	**2**	2	0	0	CV	NPTEL	***	***	2	50
19	MHT442P	IV	Major Project	**18**	0	0	18	CV	Project	***	100	3	100
			Total Credits	**80**	**36**	**5**	**39**						

I SEMESTER ELECTIVES

Professional Core Courses (Cluster Electives) (Group-A)			
Sl.No	**Course Title**	**BoS**	**COURSE TITLE**
1	MST314A1	**CV**	Health Monitoring of Civil Engineering Structures
2	MST314A2	**CV**	Numerical Methods and optimisation
3	MST314A3	**CV**	Building Information Modelling
4	MHT314A4	**CV**	AI for Infrastructural Elements
5	MHT314A5	**CV**	Infrastructure Finance and Economics

II SEMESTER ELECTIVES

Program Specific Courses (Electives) (Group-B)			
Sl.No	**Course Title**	**BoS**	**COURSE TITLE**
1	MHT323B1	**CV**	Transportation Planning
2	MHT323B2	**CV**	Asset Management
3	MHT323B3	**CV**	Special Problems in Road Construction
4	MHT323B4	**CV**	Intelligent Transportation System
5	MHT323B5	**CV**	Road Projects

Professional Core Courses (Cluster Electives) (Group-C)			
Sl.No	**Course Title**	**BoS**	**COURSE TITLE**
1	MST324C1	**CV**	Design of Concrete Bridges
2	MST324C2	**CV**	Design of Sub structures
3	MST324C3	**CV**	Prestressed and Precast Elements
4	MST324C4	**CV**	Reliability based analysis in Civil Engineering
5	MHT324C5	**CV**	Urban and Regional Planning
6	MHT324C6	**CV**	Logistics in Transportation Engineering

Interdisciplinary Courses (Global Electives) (Group-D)			
SL. NO.	**BoS**	**COURSE CODE**	**COURSE TITLE**
1	**BT**	MBT325DA	Nature Impelled Engineering
2	**BT**	MBT325DB	Clinical Data Management
3	**CS**	MCN325DC	Cyber Forensics and Cyber Laws
4	**CV**	MCV325DD	Industrial Safety and Health
5	**CV**	MCV325DE	Advanced Technologies for Transportation Systems
6	**EC**	MEC325DF	Design & Implementation of Human-Machine Interface
7	**EE**	MEE325DG	Electric Vehicle Technology
8	**ET**	MET325DH	Electronic Navigation Systems
9	**ET**	MET325DJ	Vehicular Communication Ecosystem
10	**IM**	MIM325DK	Essentials of Project Management
11	**IS**	MIS325DM	User Interface & User Experience
12	**MA**	MMA325DN	Mathematical Methods for Data Science
13	**ME**	MME325DO	Industry 4.0: The Smart Manufacturing
14	**ME**	MME325DQ	Industrial Internet of Things (IIoT)

III SEMESTER ELECTIVES Professional Elective Courses (NPTEL) (Group-E)			
Sl.No	**BoS**	**Course Code**	**COURSE TITLE**
1	**CV**	MST332E1	Interior Design
2	**CV**	MST332E2	Development and Applications of Special Concretes
3	**CV**	MST332E3	Earthquake Resistant Design of Foundations
4	**CV**	MHT332E4	Expansive Soil
5	**CV**	MHT332E5	Construction Methods and Equipment Management

IV SEMESTER ELECTIVES Program Specific Courses (NPTEL-Elective) (Group-F)			
Sl.No	**BoS**	**Course Code**	**COURSE TITLE**
1	**CV**	MST341F1	Introduction to Accounting and Finance for Civil Engineers
2	**CV**	MST341F2	Structure, Form and Architecture: The Synergy
3	**CV**	MHT341F3	Plastic Waste Management
4	**CV**	MHT341F4	Sustainable Engineering Concepts and Life Cycle Analysis

SEMESTER: I						
Course Code	:	MMA211TA	**Applied Mathematics**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	(*Theory: Common to* MBT, MHT, MMD, MPD, MST)	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Professional Core Course)*	SEE Duration	:	3 Hours

Unit-I	**09 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	**09 Hrs**
Random variables and Probability Distributions: Random variables-discrete and continuous, probability mass function, probability density function, cumulative distribution function, mean and variance. Discrete distributions - binomial, Poisson distributions. Continuous distributions - exponential and normal distributions.	
Unit –III	**09 Hrs**
Sampling and Inferential Statistics: Population and sample mean and proportion of sample, central limit theorem, Sampling distributions - sampling distributions of means, sampling distributions of proportions. Principles of statistical inference, null and alternative hypothesis, Type –I and Type – II errors, level of significance, One tailed and two tailed tests, z- test, t- test.	
Unit –IV	**09 Hrs**
Engineering optimization: Engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function and objective function surface. Constrained optimization – Lagrange multipliers, multivariable optimization with inequality constraints-Kuhn-Tucker conditions.	
Unit –V	**09 Hrs**
Numerical solution of differential equations: Boundary value problems–finite difference method for linear differential equations, shooting method. Finite difference methods for parabolic, elliptic and hyperbolic partial differential equations.	

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

CO1	:	Explore the fundamental concepts of random variables, probability distributions, sampling, statistics, optimization and numerical methods.
CO2	:	Apply theoretical concepts of discrete and continuous random variables, probability distributions, sampling, statistics optimization and numerical methods to evaluate the problems of engineering applications.
CO3	:	Analyze the solution of the engineering problems solved using appropriate techniques of random variables, probability distributions, sampling theory, statistics optimization and numerical methods.
CO4	:	Enhance the comprehensive understanding of random variables, probability distributions, sampling theory, statistics optimization and numerical methods gained to demonstrate the problems arising in many practical situations.

References
1. Probability & Statistics for Engineers & Scientists, Ronald E. Walpole & Raymond H. Myers, 9th Edition, 2016, Pearson Education, ISBN-13: 978-0134115856.
2. Applied Statistics and Probability for Engineers, Douglas C. Montgomery and George C. Runger, 6th Edition, 2014, John Wiley & Sons, ISBN:13 9781118539712, ISBN (BRV):9781118645062.
3. M K Jain, S. R. K. Iyengar, R. K. Jain; Numerical methods for scientific and engineering computation; New Age International Publishers; 6th Edition; 2012; ISBN-13: 978-81-224- 2001-2.
4. Singiresu S. Rao, Engineering Optimization Theory and Practice, New Age International (P) Ltd., 3rd Edition,2019, ISBN: 81-224-1149-5.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks]**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **THREE quizzes** will be conducted (Two regular quizzes and one optional improvement quiz) & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **THREE** tests will be conducted (Two regular tests and one optional improvement test). Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: I						
Course Code	:	MHT312IA	**Pavement Materials**	CIE Marks	:	100 + 50
Credits L-T-P	:	3-0-1	*(Theory & Practice)*	SEE Marks	:	100 + 50
Hours	:	45L+45EL +30P	*(Professional Core Course with Integrated Lab) -1*	SEE Duration	:	3+3 Hours

UNIT - I	**9 Hours**
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- characterization and application in highways, ground improvement techniques	
UNIT - II	**9 Hours**
Aggregates–Natural and Manufactured Aggregates, Tests, specifications and gradation on road aggregates for flexible and rigid pavements. Importance of aggregate gradation, shape factors, characterization, permeability, particle packing density concepts- Bailey Method	
UNIT - III	**9 Hours**
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	**9 Hours**
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	**9 Hours**
Alternate materials – GGBS, Silica Fumes, construction and demolition waste, flyash, admixture – plasticizers, super plasticizers, retarders, other admixtures, cold mixes and emulsion treated mixes, characterization	
LABORATORY	**30 Hours**
1. CBR test 2. Tests on bitumen: Penetration on aged binders, Viscosity using rotational viscometer 3. Tests on bituminous mixes: Bitumen extraction and gradation, Mix design by Marshall Method for dense bituminous mixes, Indirect Tensile Strength (ITS) test for bituminous mixes, Indirect tensile repeated load tests. 4. Mix design for pavement quality concrete.	

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

References

1. Prithvi Singh Kandhal, Veeraragavan. A and Rajan Choudhary, 'Bituminous Road Construction in India', 2nd Edition, PHI Learning, ISBN: 9789391818821, 2023
2. Freddy L Roberts, Prithvi S Kandhal, Brown, E R, Lee, D-Y, Kennedy, T W "Hot Mix Asphalt Materials, mixture design and construction", 2nd Edition, National Asphalt Pavement Association Research and Education Foundation, Maryland, USA, ISBN-10: 0914313010, 1996
3. HMSO, "Soil Mechanics for Road Engineers"- Her Majesty's Stationary Office, 1952 Publication, Edition -1, ISBN 10: 0115502785, ISBN 13: 9780115502781
4. Huang, "Pavement Analysis and Design", Pearson Publications, Edition -11, ISBN-13:9780131424739, 2004

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)

CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks]**

Sl.No.	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	CIE THEORY TOTAL	**100**

RUBRIC FOR CONTINUOUS INTERNAL EVALUATION (CIE-Lab)

Q.NO.	CONTENTS	MARKS
1	Conduction of the Experiments & Lab Record	30
2	Open-ended Lab Experiment	10
3	Lab Test	10
	CIE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE CIE	**150**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	SEE THEORY TOTAL	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Lab)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva-Voce	10
	SEE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE SEE	**150**

SEMESTER: I						
Course Code	:	MHT313IA	**Highway Geometric Design**	CIE Marks	:	100 + 50
Credits L-T-P	:	3-0-1	*(Theory & Practice)*	SEE Marks	:	100 + 50
Hours	:	45L+45EL+ 30P	*(Professional Core Course with Integrated Lab) -2*	SEE Duration	:	3+3 Hours

UNIT - I	**9 Hours**
Cross sectional elements: F actors 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, Typical cross sections for urban and non-urban roads	
UNIT - II	**9 Hours**
Geometric Design Elements: S ight 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, problems	
UNIT - III	**9 Hours**
At-grade Intersections: types, alignment and profile, intersection sight distance, turning roadways and channelization, auxiliary lanes, median openings, roundabout design, railroad–highway grade crossings, other intersection design considerations-frontage roads, traffic control devises, cyclists, pedestrians, lighting, drive ways, case studies	
UNIT - IV	**9 Hours**
Grade separators and Interchanges: types, warrants, economic factors, grade separation structures- underpass, overpass, interchanges – configurations, general design considerations, three-leg designs, four-leg designs, ramps, other interchange design features, case studies	
UNIT - V	**9 Hours**
Road way facilities and Road safety Furniture: pedestrian facilities, bus bay, truck lay bays, frontage roads, parking areas, cattle crossings, lighting, toll plazas, operation and maintenance centre, landscaping and tree plantation, Case studies Road Safety furniture- signage, markings, road humps, traffic calming measures as per IRC	
LABORATORY	**30 Hours**
1. Topographic survey of given road stretch covering an intersection using total station / DGPS for geometrical improvement 2. Preparation of plan, longitudinal section, cross section for the geometrical improvements indicating road safety furniture in the drawing 3. Preparation of intersection drawing for improvements indicating road safety furniture in the drawing	

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

CO1	:	Explain the cross sectional elements and sight distance requirements for various types of roads and terrain conditions for comfort and safe maneuverability of vehicles
CO2	:	Analyse the components of horizontal and vertical alignment for varied speed and terrain conditions for design of highway geometry
CO3	:	Plan and design intersections, grade separators and interchanges for urban and non-urban roads for safe and efficient mobility
CO4	:	Propose the geometry for greenfield, widening and improvements of different classes of existing highways to meet design traffic

References

1. AASHTO, A Policy on Geometric Design of Highways and Streets, (The Green Book) 7th Edition, American Association of State Highway and Transportation Officials (AASHTO) Publishers, 2018, ISBN Number: 978-1-56051-676-7
2. Khanna S.K, Justo CEG, Veeraragavan A "Highway Engineering" Nem Chand & Sons, Revised 10th Edition,2017, ISBN: 10 8185240930
3. John G Schoon "Geometric design projects for Highways: An Introduction" 2nd Edition, American Society of Civil Engineers Press, ISBN: 978-0-7844-7042-8, 2000
4. Indian Roads Congress Publications, New Delhi; IRC 11, IRC12,IRC 32,IRC: 52,IRC64,IRC66,IRC73,IRC80,IRC86, IRC 92,IRC SP 23,IRC SP 88,IRC SP 99, Indian Roads Congress, New Delhi.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)

CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks]**

Sl.No.	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	CIE THEORY TOTAL	**100**

RUBRIC FOR CONTINUOUS INTERNAL EVALUATION (CIE-Lab)

Q.NO.	CONTENTS	MARKS
1	Conduction of the Experiments & Lab Record	30
2	Open-ended Lab Experiment	10
3	Lab Test	10
	CIE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE CIE	**150**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	SEE THEORY TOTAL	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Lab)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva-Voce	10
	SEE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE SEE	**150**

SEMESTER: I						
Course Code	:	MST314A1	**Health Monitoring of Civil Engineering Structures**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+ 30T	*(Professional Cluster Elective - Group A)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Structural Health: Factors affecting Health of Structures, Causes of Distress, Regular Maintenance, Case studies. Structural Health Monitoring: Definition of SHM – Classification, Types and Components of SHM, Various Measures, Structural Safety in Alteration.	
UNIT - II	**9 Hours**
Materials: Piezo–electric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique, calibration, testing and inferences/interpretation of data. Structural Audit: Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures, Non – Destructive Testing (NDT), calibration of NDT equipment, repeatability and reproducibility of test results, inferences, applications, remedial measures.	
UNIT - III	**9 Hours**
Static Field Testing: Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement, Case studies	
UNIT - IV	**9 Hours**
Dynamic Field Testing: Types of Dynamic Field Test, Stress History Data, Dynamic Response Method, applications, case studies .	
UNIT - V	**9 Hours**
Remote Structural Health Monitoring: Introduction, Hardware for Remote Data Acquisition Systems, Advantages, Case studies on conventional and Remote structural health monitoring; remedial measures, evaluation of effectiveness of the alternate remedial measures, AI/ML applications; prediction of performance	

Course Outcomes:

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

CO1	:	Diagnose the distress in the structure understanding the causes and factors.
CO2	:	Understand safety aspects, components and materials used in Structural Health Monitoring.
CO3	:	Assess the health of structure using static field methods and dynamic field tests.
CO4	:	Analyse behavior of structures using remote structural health monitoring

References

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, “Structural Health Monitoring”, 2006, John Wiley and Sons, Print ISBN:9781905209019, Online ISBN:9780470612071, DOI:10.1002/9780470612071.
2. Vistasp M. Karbhari and Farhad Ansari, “Structural Health Monitoring of Civil Infrastructure Systems”, Woodhead Publishing, 1st Edition, 2009, ISBN 978-1-84569-392-3
3. Hua-Peng Chen, Yi-Qing Ni, “Structural Health Monitoring of Large Civil Engineering Structures” 1st Edition, 2018, John Wiley & Sons Ltd, Print ISBN:9781119166436, Online ISBN:9781119166641, DOI:10.1002/9781119166641
4. Gangbing Song, Chuji Wang and Bo Wang, “Structural Health Monitoring of Civil Structures”, 1st Edition, 2018, MDPI AG, 2018, ISBN-10: 3038427837. ISBN-13: 978-3038427834.
5. Hugo Rodrigues and Ivan Duvnjak, Advanced Structural Health Monitoring: From Theory to Applications, MDPI, ISBN 978-3-0365-5035-0 (Hbk), ISBN 978-3-0365-5036-7 (PDF)

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: I						
Course Code	:	MST314A2	**Numerical Methods and Optimization**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+ 30T	*(Professional Cluster Elective - Group A)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Introduction: Introduction to optimization, engineering applications of optimization, Optimization Techniques: Classical optimization techniques, single variable optimization, multivariable optimization with no constraints, unconstrained minimization techniques and algorithms constrained optimization solutions by penalty function techniques, Lagrange multipliers techniques and feasibility techniques.	
UNIT - II	**9 Hours**
Linear Programming: Linear programming, standard form of linear programming, geometry of linear programming problems, solution of a system of linear simultaneous equations, pivotal production of general systems of equations, graphical solution, solution by simplex and revised simplex technique, duality in linear programming	
UNIT - III	**9 Hours**
Non-linear programming: Non-linear programming, one dimensional minimization methods, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic and cubic methods, Unconstrained optimization methods, direct search methods, random search methods, descent methods	
UNIT - IV	**9 Hours**
Statistical inferences: Methods of least square and regression, multiple regression. Concept of probability, Random Variables, Binomial, Poisson and Normal distribution –applications, Chi-squared test and Analysis of Variance.	
UNIT - V	**9 Hours**
Numerical Solutions: Solution of Ordinary differential equations: Euler's method, and RangaKutta 3rd and 4th order method, Taylor's series method Solutions for Integral Equations: Trapezoidal rule, Simpson's 1/3rd and 3/8th rule, and Weddle's Rule.	

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

CO1	:	Formulate structural optimization problems and carry out linear programming by solving a system of linear simultaneous equations
CO2	:	Apply different non-linear programming methods
CO3	:	Analyze the data and characterize with regression equations and test its efficacy
CO4	:	Solve Differential equations using numerical metods

References

1. Rao,S.S., "Engineering Optimization", John Wiley & Sons,4th Edition,2009, ISBN :0470183527
2. Johnson R and G Bhattacharya, "Statistics – Principles and methods"- John Wiley & sons, New york,4th Edition,2000, ISBN: 0-471-388971
3. M K Jain, S.R.K Iyengar, R K. Jain, "Numerical methods for Scientific and Engg. Computation", New Age International,4th Edition, 2005, ISBN: 8122414613
4. Bhavikatti S. S., "Structural optimization using sequential linear programming" Vikas publishing,2003, ISBN: 8125911812, Edition -1

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 &10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: I						
Course Code	:	MST314A3	**Building Information Modelling**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Professional Cluster Elective - Group A)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Introduction to BIM: Understanding BIM Definition and Importance of BIM, Definition and evolution of Building Information Modeling. Key Concepts and Terminology BIM Standards. Key benefits and uses of BIM in the construction and AEC sectors. BIM vs. Traditional CAD: Differences between BIM and CAD. Advantages of BIM in project management and lifecycle cost analysis. BIM Levels of Development: Understanding Level of Development (LOD) and its implications in design and construction. Introduction to BIM Dimensions (4D, 5D, 6D).	
UNIT - II	**9 Hours**
MoBIM Uses in Architecture: Application of BIM in architectural design and documentation. BIM Uses in Structural Engineering: Application of BIM for structural design and analysis. BIM Uses in MEP (Mechanical, Electrical, Plumbing) MEP coordination and system integration using BIM. BIM in Facility Management: The role of BIM in operations and maintenance (O&M).	
UNIT - III	**9 Hours**
BIM Process Overview: Understanding BIM process flow from planning to construction and maintenance. Key stages of a BIM project lifecycle. BIM Execution Plan: Developing a BIM execution plan (BEP), Roles and responsibilities in BIM teams. Coordination and Collaboration: Strategies for effective collaboration using BIM. Benefits of interdisciplinary coordination in BIM projects.	
UNIT - IV	**9 Hours**
National and International BIM Standards: Overview of BIM standards and guidelines (e.g., ISO 19650). BIM Compliance and Implementation: Steps to implement and comply with BIM standards. Importance of data management and information sharing in BIM projects. BIM Interoperability: Discussing interoperability issues and solutions, Importing/exporting BIM data across platforms.	
UNIT - V	**9 Hours**
Emerging Technologies in BIM: The impact of emerging technologies like AI, VR, AR, and IoT on BIM. BIM Careers and Opportunities: Career opportunities and skillsets required in the BIM industry. BIM Evolution and Trends: Current trends and future directions in BIM, The role of BIM in smart cities and digital twin technologies.	

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

CO1	:	Demonstrate a thorough understanding of BIM concepts and terminology and apply international and national BIM standards and protocols effectively in projects.
CO2	:	Understand the application of BIM techniques in the design, construction, operation, maintenance, and renovation phases of a project, and facilitate effective collaboration and coordination among project stakeholders using BIM tools and techniques.
CO3	:	Analyze and implement BIM concepts in infrastructure, structural projects, and emerging technologies.
CO4	:	Analyze and manage BIM projects effectively.

References
1. Willem Kymmell," Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations", McGraw-Hill Construction Series,1st Edition,2008, ISBN: 9780071494533
2. Brad Hardin and Dave McCool," BIM and Construction Management: Proven Tools, Methods and Workflows", Wiley;2nd edition,2011, ISBN-10:118942760, ISBN-13:978-1118942765
3. A Practical Guide to Adopting BIM in Construction Projects by Bimal Kumar, Whittles Publishing, Edition -1,2015, ISBN – 13 978-1849951463
4. Chuck Eastman, Paul Teicholz, Rafael Sacks,and Kathleen Liston ,"BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers", John Wiley & Sons Inc; 2nd edition,2011, ISBN-10 : 9780470541371,ISBN-13 : 978-0470541371

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 &10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: I						
Course Code	:	MHT314A4	**AI for Infrastructural Elements**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Professional Cluster Elective - Group A)*	SEE Duration	:	3 Hours

UNIT – I	**9 Hours**
Introduction to AI: Introduction to AI, definition of AI, Historical evolution of AI, AI types, brief introduction to the branches of AI, Machine learning, Natural Language processing, computer vision, robotics, expert systems, Artificial neural networks and deep learning, evolutionary computation, cognitive computing, and swarm intelligence. Applications in civil engineering in each branch of AI.	
UNIT – II	**9 Hours**
Machine Learning: Introduction to ML, Machine learning process model, Concept learning, general-to specific ordering, Version spaces, inductive bias, general to specific ordering, introduction to different kinds of machine learning, supervised, unsupervised, semi supervised, reinforcement, transfer learning and federated learning. The related algorithms under each type of ML, Applications of different ML techniques in Civil Engineering. Well posed learning problem, designing a learning system, examples.	
UNIT – III	**9 Hours**
Artificial neural networks (ANN): Introduction, biological motivation, appropriate problems in ANN learning, perceptron's, the representational power of perceptions, multilayer networks, back propagation. Introduction to recurrent neural networks, and deep learning. Illustrative real-world examples on applications of neural networks in highway/ infrastructure construction management and other civil engineering domains.	
UNIT – IV	**9 Hours**
Learning under uncertainty and ambiguity, fuzzy logic, linguistic variables, fuzzy sets, membership functions, fuzzy set operations, fuzzy expert systems, fuzzification, defuzzification, fuzzy rules, fuzzy inferences. Fuzzy inference system, Illustrative examples of engineering applications of fuzzy logic with specific reference to civil engineering	
UNIT – V	**9 Hours**
Introduction to Computer Vision: Definition and scope, history and evolution, Image acquis ion, image representation (grey scale and color), basic operations like filtering, thresholding. Primitives of image processing, geometric primitives, 2d Transforms, 3D transforms, photometric image formation, lighting, reflectance and shading, the digital camera, sampling and aliasing. Applications of computer vision in Civil engineering.	

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

CO1	:	Obtain insights into the role of AI in modern civil engineering practices and how it can enhance decision-making and efficiency.
CO2	:	Comprehend the structure and functioning of Artificial Neural Networks, including various architectures and learning algorithms, and apply ANN techniques to model and solve real-world civil engineering problems.
CO3	:	Apply the principles of Fuzzy Logic and apply the same in handling uncertainty and imprecision in Civil engineering problems.
CO4	:	Implement computer vision and image processing techniques, and be able to implement computer vision methods for automated inspection, monitoring, and assessment of civil infrastructure

References
1. Kothari Dwarkadas Pralhaddas, SamuiPijush, "Artificial Intelligence in Civil Engineering", Lambert Academic Publishing, 2012, Edition -1 ISBN-10:3659287172
2. Stuart Russel, Peter Norvig, "Artificial Intelligence- A modern approach", Pearson Education; 4th edition,2022, ISBN-10: 93560635
3. Tom.M.Mitchel, "Machine Learning", Mc Graw Hill,1st Edition, 2017, ISBN-10: 1259096955
4. Margaret A Boden," Artificial Intelligence", Academic Press London, 1st Edition,1996, ISBN: 9780121619640

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1&2	Unit 1: Question 1 or 2	20
3&4	Unit 2: Question 3 or 4	20
5&6	Unit 3: Question 5 or 6	20
7&8	Unit 4: Question 7 or 8	20
9&10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: I						
Course Code	:	MHT314A5	**Infrastructure Finance and Economics**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Professional Cluster Elective - Group A)*	SEE Duration	:	3 Hours

UNIT – I	**9 Hours**
Introduction to Infrastructure Economics: Overview, Types of Infrastructure, Economic Characteristics of Infrastructure, Role of Infrastructure in Economic Growth and Productivity, Government's Role and Public vs. Private Provision of Infrastructure.	
UNIT – II	**9 Hours**
Infrastructure Financing: Traditional Infrastructure Financing Mechanisms, Cost Recovery Mechanisms and Pricing of Infrastructure Services, The Economics of Toll Roads, Utility Pricing, and Subsidies and Case Studies of Public Infrastructure Financing Models, Public-Private Partnerships (PPPs), Emerging Trends in Infrastructure Finance.	
UNIT - III	**9 Hours**
Project Appraisal and Evaluation: Economic Evaluation of Infrastructure Projects: Cost-Benefit Analysis (CBA), Cost-Effectiveness Analysis (CEA), Financial Evaluation: Net Present Value (NPV), Internal Rate of Return (IRR), Sensitivity Analysis, Public vs. Private Benefits and the Role of Social Discount Rates and Case Study: Evaluating Infrastructure Projects in Developing Economies.	
UNIT - IV	**9 Hours**
Infrastructure Investment and Risk: Financial Risks in Infrastructure Projects: Demand, Construction, Operational, Political, and Currency Risks, Risk Mitigation Strategies in Infrastructure Projects, Role of Insurance, Hedging, and Guarantee Mechanisms in Infrastructure Finance, Assessing Risk in PPPs vs. Publicly Funded Infrastructure Projects.	
UNIT - V	**9 Hours**
Infrastructure Governance and Regulatory Issues: Regulatory Frameworks for Infrastructure Sectors: Energy, Transport, Water, and Telecommunications, Pricing and Tariff Setting in Infrastructure Services, Managing Infrastructure Monopolies and Competition Policy, Governance Models and the Role of International Organizations (e.g., World Bank, IMF, OECD), Infrastructure and Sustainable Development.	

Course Outcomes:

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

CO1	:	Demonstrate economic principles relevant to infrastructure projects and evaluate their role in economic development.
CO2	:	Apply cost-benefit analysis, valuation techniques, and financial models to assess the economic viability of infrastructure projects
CO3	:	Formulate financing strategies that integrate public, private, and alternative funding sources to support sustainable infrastructure projects
CO4	:	Identify and assess financial and operational risks in infrastructure projects, and propose effective risk mitigation techniques to enhance project resilience

References
1. "Infrastructure Finance: The Business of Infrastructure for a Sustainable Future" by Paul M. McGill, S. R. M. Lee, and Andrew D. K. Hodge ,2017, ISBN-10. 0470481781 · ISBN-13. 978-0470481783
2. "Infrastructure as an Asset Class: Investment Strategies, Project Finance and PPP" by Barbara Weber and Hans Wilhelm Albrecht ,2020, ISBN - 0470537310
3. "Infrastructure Economics and Policy" José A. Gómez-Ibáñez and Zhi Liu, Lincoln Institute of Land Policy, 2021, ISBN: 978-1-55844-418-8
4. "The Economics of Public Private Partnerships" by E.R. Yescombe (2007), Paperback ISBN: 9781493303236, 978 -1 - 4933 - 0323 – 6, Hardback ISBN: 9780750680547, 978 -0-7506 - 8054 – 7, eBook ISBN: 9780080489575

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: I						
Course Code	:	MHT415SL	**Skill Laboratory**	CIE Marks	:	50
Credits L-T-P	:	0-0-2	*(Laboratory)*	SEE Marks	:	50
Hours/Week	:	4	*(Practice)*	SEE Duration	:	2 Hours

Contents

Road surveying using

- Total Station / DGPS

Road infrastructure drafting using

- AutoCAD

Forecast models using

- Python / MATLAB

Course Outcomes:

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

CO1	:	Enhance problem solving abilities
CO2	:	Develop professional skills

References

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", The MIT Press, 3rd Edition, 2009, ISBN: 978-0262033848
2. Prithvi Singh Kandhal, Veeraragavan. A and Rajan Choudhary, 'Bituminous Road Construction in India', 2nd Edition, PHI Learning, ISBN: 9789391818821, 2023
3. AASHTO, A Policy on Geometric Design of Highways and Streets, (The Green Book) 7th Edition, American Association of State Highway and Transportation Officials (AASHTO) Publishers, 2018, ISBN Number: 978-1-56051-676-7

RUBRIC FOR CONTINUOUS INTERNAL EVALUATION (CIE-Lab)		
1	Conduction of the experiments relevant to the modules & Report	15
2	Design and testing of the Prototype / Projects / Modules	20
3	Final presentation and report	15
	MAXIMUM MARKS FOR THE SEE	**50**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Lab)

The evaluation will be carried out by Internal and External examiners through Exhibition Mode.
The following weightage would be given for the exhibition.

Q.NO.	CONTENTS	MARKS
1	Presentation through posters	15
2	Demonstration of the Prototype / Projects / Modules	25
3	Viva-Voce	10
	MAXIMUM MARKS FOR THE SEE	**50**

SEMESTER: I						
Course Code	:	HSS116EL	**Technical English** (Common to all Programs)	CIE Marks	:	50
Credits L-T-P	:	0-0-1	Online English Laboratory Course	SEE Marks	:	50
Hours	:	30P	Humanities and Social Sciences	SEE Duration	:	2 Hours

UNIT – I	**10 Hours**
The Basics. Business Documents, Questions, and the Technical Pursuit. Engineering Concepts and Complexity; The Future Tense for Technical Work. White Papers; Modifiers and Qualifiers.	
UNIT – II	**10 Hours**
Making Recommendations; Interpreting Data, Ethical Persuasion for Technical Projects; Cause and Effect; Calls for Proposals. Technical Complexity in Communication. Numbers, Plain English, Jargon, and Technical Terms, Active and Passive Structures.	
UNIT – III	**10 Hours**
Organization Needs; Seeing the Big Picture; Negotiating. Audience Needs and Assessment; Standards versus White Papers; Objectivity, Communicating within Expected Genres; Identifying Trustworthy Sources or Bias in. A Review of Major Course Takeaways.	

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

CO1	:	Demonstrate clarity and precision in technical communication by structuring information effectively, balancing technical terms with plain English, and adapting to diverse audiences.
CO2	:	Analyze and produce professional documents, such as white papers, business proposals, and reports, while applying ethical persuasion, data interpretation, and evidence-based reasoning.
CO3	:	Evaluate and refine communication strategies by assessing audience needs, recognizing trustworthy sources, and navigating organizational and technical complexities.
CO4	:	Apply critical thinking and negotiation skills to align communication with organizational goals, anticipate future challenges, and support informed decision-making.

References

1. IEEE – EBSCO Technical English for Professionals – Online platform
2. Valerie Lambert, Elaine Murray, English for Work – Everyday Technical English, Pearson Education, 2003, ISBN- 0 582 53963-3
3. David Bonamy, Christpher Jacques, Technical English – First Course Book, Pearson Education, 2008
4. S Sumant. Technical English I, The McGraw Hill, 2011, ISBN -978 81 8209 308 9

Assessment and Evaluation Pattern (Online Mode)		
	CIE (Online Mode)	**SEE (Online Mode)**
Weightage	**50%**	**50%**
Test – I	Each test will be conducted for 50 marks adding to 100 marks. Final test marks will be reduced to 40 marks	**Final assessment will be conducted for 50 marks**
Test – II		
Experiential Learning	10 Marks	
Communication Skills- Activity based test – Script writing, Essay Writing, Role plays. Any other activity that enhances the Communication skills. The students will be assigned with a topic by the faculty handling the batch. The students can either prepare a presentation/write essay/role play etc. for the duration (4-5 minutes per student). **Parameters for evaluation of the Presentation** a. Clarity in the presentation/ Speaking/Presentation skills. b. Concept / Subject on which the drama is enacted/ scripted		
Maximum Marks	50 Marks	**50 Marks**
Total marks for the course	**50**	**50**

SEMESTER: II						
Course Code	:	MHT321IA	**Pavement Design**	CIE Marks	:	100 + 50
Credits L-T-P	:	3-0-1	*(Theory & Practice)*	SEE Marks	:	100 + 50
Hours	:	45L+45EL+30P	*(Professional Core Course with Integrated Lab) - 3*	SEE Duration	:	3+3 Hours

UNIT - I	**9 Hours**
Pavements-types, functions, Factors affecting design and performance of bituminous, composite and concrete pavements–Pavement design factors, loads–axle load distribution, ESWL, EWL, VDF, life cycle cost analysis, sustainability, choice of pavement type.	
UNIT - II	**9 Hours**
Pavement Materials: subgrade support evaluation, Resilient Modulus, fatigue tests, permanent deformation, factors affecting design and performance of highway and airport pavements – pavement material characterization, climatic, drainage and environmental factors, their effects and evaluation.	
UNIT - III	**9 Hours**
Stresses and Deflection/strain in flexible pavements: Application of elastic layered theory, stresses, deflections/strains in single, two and three and multi – layer system, Applications in pavement design. Software applications.	
UNIT - IV	**9 Hours**
Bituminous pavement design: Empirical, mechanistic- empirical and theoretical design approaches, principle, advantages and application. Alternate pavement design by MEPDG as per IRC, common design methods such as AASHTO, Asphalt Institute and Shell methods, software applications	
UNIT - V	**9 Hours**
Concrete pavement design: Determination of ESWL, EWL for dual and dual tandem wheel loads in Rigid pavements, General design principle, Stresses in rigid pavements, stresses due to wheel loads and temperature variations, design of cement concrete pavements, roller compacted concrete pavements, cell filled concrete pavements; design of white topping as per IRC guidelines, design of continuously reinforced concrete pavements, design of fibre reinforced concrete pavements, design of paneled concrete pavements, design of interlocking software applications	
LABORATORY	**30 Hours**

1. Axle load survey analysis and computation of VDFs/ Truck Factors
2. Traffic survey analysis and Prediction of Design Traffic
3. Stress analysis – single, two and multi-layer using KENPave and IITPave
4. Design of alternate bituminous pavements as per IRC
5. Design of composite pavements, as per IRC
6. Design of Concrete pavements - as per IRC
7. Design of pavements for low volume rural roads
8. Life Cycle Cost Analysis / Life Cycle Assessment

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

References
1. Yoder and Witczak , "Principles of Pavement Design", , (second edition) 1975, -John Wiley and sons Inc, ISBN : 978-81-265-3072-4
2. Rajib B. Mallick, Tahar El-Korchi, Pavement Engineering – Principles and Practice, CRC Press, 2023, Edition -4, ISBN 9780367758073
3. Nick Thom, 'Principles of Pavement Design', Third Edition ICE Publishing, 2024, ISBN: 978-1-83549-710-4 | ISBN: 978-1-83549-711-1
4. Huang, "Pavement Analysis and Design",2004 –Pearson Publications, Edition -2, ISBN-13:9780131424739

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks]**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	CIE THEORY TOTAL	**100**

RUBRIC FOR CONTINUOUS INTERNAL EVALUATION (CIE-Lab)		
Q.NO.	**CONTENTS**	**MARKS**
1	Conduction of the Experiments & Lab Record	30
2	Open-ended Lab Experiment	10
3	Lab Test	10
	CIE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE CIE	**150**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	SEE THEORY TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Lab)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva-Voce	10
	SEE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE SEE	**150**

SEMESTER: II						
Course Code	:	MHT322IA	**Traffic Engineering and Management**	CIE Marks	:	100 + 50
Credits L-T-P	:	3-0-1	*(Theory & Practice)*	SEE Marks	:	100 + 50
Hours	:	45L+45EL+30P	*(Professional Core Course with Integrated Lab) -4*	SEE Duration	:	3+3 Hours

UNIT - I	**9 Hours**

Traffic Surveys and analysis

Scope, traffic elements-road, road user and vehicle. 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.

UNIT - II	**9 Hours**

Fundamental principles of Traffic flow

Traffic flow elements, flow- density relationship, shockwaves in traffic stream. Gap and gap acceptance, Introduction to queuing theory.

UNIT - III	**9 Hours**

Capacity and level of service

Concepts and factors affecting Capacity and level of service, analysis and performance measures for level of service at highways and signalised intersections.

UNIT – IV	**9 Hours**

Accident and Road Safety

Accident characteristics, causes, studies, investigations and analysis of individual accidents, statistical analysis.

Global & Local perspective – Road safety issues – Road safety programs – Types of RSA, planning, design, construction & operation stage audits – Methodology – Road safety audit measures

UNIT - V	**9 Hours**

Traffic forecasting, regulation and management

Factors affecting traffic forecast, Common methods of traffic forecast, Traffic regulation, control and safety: Regulation on vehicles, drivers and traffic flow, Parking studies, Traffic control devices – Types & objectives of markings, signs, signals and islands, delineators.

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

LABORATORY	**30 Hours**

1. Classified traffic Volume Count survey – mid block
2. Turning Movement Count at an Intersection
3. Conflict points at different types of intersections
4. Spot speed Survey
5. Speed and Delay survey
6. Parking Inventory & Usage Survey by Patrol
7. Signal design

Course Outcomes:		
After going through this course the student will be able to:		
CO1	:	Design, conduct and analyse the traffic data to identify trends and forecast traffic demand
CO2	:	Describe, analyse, apply and interpret the traffic flow characteristics
CO3	:	Identify key accident causing factors, propose and design safety measures based on accident analysis.
CO4	:	Identify, evaluate, design and optimize traffic control devices to improve performance of traffic flow.

References

1. Nicholas J. Garber and Lester A. Hoel "Traffic and Highway Engineering", 5th edition, CL Engineering, 2019. The MIT Press, 3rd Edition, 2009, ISBN:978-1337631044.
2. R Srinivasa Kumar, "Introduction to traffic engineering", South Asian Edition, The Orient Blackswan, 2018, ISBN-978-9386235473.
3. Roger P. Roess, Elena S. Prassas and William R. McShane, "Traffic Engineering", Fifth Edition, Pearson Education,2019, ISBN- 978-9353434854.
4. L R Kadyali, "Traffic Engineering and Transportation Planning", , Khanna Publishers, 2016, Edition -7, ISBN 13 - 978-8174092205

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)

CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks]**

Sl.No.	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	CIE THEORY TOTAL	**100**

RUBRIC FOR CONTINUOUS INTERNAL EVALUATION (CIE-Lab)		
Q.NO.	**CONTENTS**	**MARKS**
1	Conduction of the Experiments & Lab Record	30
2	Open-ended Lab Experiment	10
3	Lab Test	10
	CIE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE CIE	**150**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B	
2 & 3	Unit 1: Question 1 or 2	16
4 & 5	Unit 2: Question 3 or 4	16
6 & 7	Unit 3: Question 5 or 6	16
8 & 9	Unit 4: Question 7 or 8	16
10 & 11	Unit 5: Question 9 or 10	16
	SEE THEORY TOTAL	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Lab)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva-Voce	10
	SEE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE SEE	**150**

SEMESTER: II						
Course Code	:	MHT323B1	**Transportation Planning**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Program Specific Course-Elective B)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Urban Transportation Systems: Types and Characteristics Importance and Scope: Role of Transportation in Urban Development Transportation Demand and Supply: Concepts, Definitions, and Influencing Factors Urban Travel Behavior: Factors Affecting Travel Patterns Planning Process Overview: Steps, Objectives, and Stakeholders	
UNIT - II	**9 Hours**
Data Collection and Surveys Data Types and Sources: Socioeconomic, Land Use, and Transportation Data Survey Methods: Household Surveys, Traffic Counts, and Origin-Destination Surveys Data Analysis Techniques: Basic Analysis and Interpretation for Planning Sampling Techniques and Survey Design: Representativeness and Accuracy Data Use in Transportation Models: Key Inputs for Modeling	
UNIT - III	**9 Hours**
Transportation Models: Types and Functions Four-Step Modeling Process: Trip Generation, Trip Distribution, Mode Choice, Route Assignment, software applications Demand Forecasting Techniques: Growth Factor Methods and Econometric Models Applications of Modeling in Planning: Scenario Analysis and Policy Evaluation Limitations and Accuracy in Modeling: Addressing Uncertainties; software applications	
UNIT - IV	**9 Hours**
Urban Transportation Systems and Management Public Transportation Systems: Planning, Operations, and Management of Non-Motorized Transportation: Pedestrian and Bicycle Facilities Intersection Management, and ITS, Planning for Smart and Sustainable Transportation System in Cities Land Use and Transportation Interaction: Impact on Urban Form and Mobility Sustainable Transportation Planning: Policies and Initiatives for Low-Carbon Mobility	
UNIT - V	**9 Hours**
Policy, Implementation, and Case Studies: National, Regional, and Local Policies Project Planning and Financing: Cost-Benefit Analysis, Funding Sources, and Public-Private Partnerships. Case Studies on transportation planning	

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

CO1	:	Demonstrate the ability to collect, analyze, and interpret transportation data
CO2	:	Apply transportation modeling techniques to forecast travel demand and evaluate transportation options.
CO3	:	Analyze the interaction between land use, environmental factors, and transportation planning
CO4	:	Examine urban transportation policies and assess their impact through case studies and contemporary issues.

References

1. Sarkar, Pradip Kumar, Maitri, Vinay And Joshi, G.J. ' Transportation Planning, Principles, Practices and Policies', PHI Learning, Third Edition, ISBN : 9788195161188
2. Hutchinson, B.G, Principles of Urban Transport System Planning, McGraw-Hill Inc.,US, 1974, Edition -1, ISBN-13: 978-0070315396,1974
3. JotinKhisty and Kent Lall B,Transportation Engineering –An Introduction, 3rd Indian Edition, PHI learning New Delhi, 2013, ISBN-13: 978-0130335609
4. Ponnuswamy S and Johnson Victor,Urban Transportation: Planning, Operation and Management,1st Edition,McGraw Hill Education (India) Private Limited,2012,ISBN-9781259002731
5. L R Kadiyali, Traffic Engineering and Transport Planning,9th Edition, Khanna Publishers, 1999, ISBN 139788174092205 Stuart Russel, Peter Norvig, Artificial Intelligence- A modern approach, II Edition.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)

CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component [20 (Q) + 40 (T) + 40 (EL) = 100 marks)

Sl.No.	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)

Q.NO.	CONTENTS	MARKS
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MHT323B2	**Asset Management**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Program Specific Course-Elective B)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**

Introduction: Network Level PMS, Basic Requirements for an Effective and Comprehensive PMS, Data Aggregation and Sectioning, Private Investment, Parallel International Developments, Administrative and Public Awareness of PMS, Improvements in Computers and Software Development, Expansion of PMS Concerns

Data requirements: Classes of Data Required, The Importance of Performance Related Pavement Evaluation, Objectivity and Consistency in Pavement Data Acquisition and Use, Combining Pavement Evaluation Measures, Purpose and types of Inventory Data, Selection and Referencing of Pavement Management Sections, Collecting and Processing Section and Network Data

UNIT - II	**9 Hours**

Pavement Performance: The Serviceability-Performance Concept, Pavement Roughness, Equipment for Evaluating Roughness, Relating Roughness to Serviceability

Evaluation of Pavement Structural Capacity: Basic Considerations, Non-destructive Measurement and Analysis, Destructive Structural Evaluation, Structural Capacity Index Concepts, Network versus Project Level Applications of Structural Capacity Evaluation

Evaluation of Pavement Surface Distress Condition Surveys: Purposes of Surface Distress Surveys- Manual and automated survey methods, Types of Distress, Equipment for Distress Evaluation, Application of Distress Data.

UNIT - III	**9 Hours**

Prediction Models for Pavement Deterioration: Clarification of Performance and Deterioration Prediction, Parameters or Measures to be Predicted, Performance Prediction Approach in the Mechanistic Empirical Pavement Design Guide (MEPDG).

Priority Programing of Rehabilitation and Maintenance: Basic Approaches to Establishing Alternatives and Policies, Priority Programing Methods, Budget Level Evaluation and Specific Standards, Final Program Selection, Developing Combined Programs of Maintenance and Rehabilitation

Rehabilitation of Existing Pavements**:** MEPDG Suggested Evaluation Data for Pavement Rehabilitation, Models, Algorithms, and Transfer Functions of the MEPDG, Use of the Guide in Pavement Management, Use of MEPDG for Rehabilitation and Overlay Design

UNIT - IV	**9 Hours**

Implementation of Pavement Management Systems: Role of Construction, Construction Linked with Maintenance and Evaluation, Role of Construction in Public-Private Partnerships, Pavement Preservation in Maintenance

Network Level Examples of Pavement Management: Evaluation of Available Information on Leading PMS Providers, Project Level Examples of PMS Software, HDM-4 Applications, Applications of Expert Systems Technology, Barriers Related to Pavement Management Implementation

UNIT - V	**9 Hours**

Cost and Benefits of Pavement Management: Quantifiable Benefits, Benefit/Cost of Developing and Using PMS, Pavement Management Roadmap, Consider User Costs and Vehicle Operating Cost in PMS

Developments in Asset Management: Framework for AMS, General Principles of Asset Management

Evolving from PMS, Network Level and Project Level, Roadblocks to AMS Implementation, Corporate Data Base and Executive Information System

Tutorial Components

1. Pavement Evaluation data analysis for functional adequacy
2. Pavement Evaluation data analysis for structural adequacy
3. Determination of pavement performance parameters
4. Pavement performance prediction modelling
5. Determination of alternative pavement maintenance strategies
6. Maintenance prioritization at network level
7. Maintenance prioritization at project level
8. Applications of software for PMS

Course Outcomes:

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

CO1	:	Analyze functional and structural deterioration of pavements, overlay types, semifield studies
CO2	:	Summarize different pavement deterioration and evaluation techniques
CO3	:	Evaluate the of models for pavement management
CO4	:	Develop the PMS for different levels

References

1. Ralph Haas and W. Ronald Hudson with Lynne Cowe Falls, 'Pavement Asset Management', Wiley, Edition -1, 2015, ISBN 978-1-119-03870-2
2. E.J.Yoder & Witczak M.W. "Principles of Pavement Design"- 2nd Edition – John Willey and Sons Inc., New York, 1975, ISBN: 978-0-471-97780-3
3. Hass R., Hudson. W. R., Zaniewisti .J. "Modern Pavement Management" – Krieger Publishing Company, Florida, 1994, ISBN: 9780070308954
4. David and Paul Croney, "Design and performance of road pavements"- third edition, Mc Graw hill, 1998, ISBN-10: 0070144516; ISBN-13: 978-0070144514

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)

CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component [20 (Q) + 40 (T) + 40 (EL) = 100 marks)

Sl.No.	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MHT323B3	**Special Problems in Road Construction**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Program Specific Course-Elective B)*	SEE Duration	:	3 Hours

UNIT - I **9 Hours**

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 **9 Hours**

Methods of strengthening weak foundation soil- acceleration of consolidation and settlement of compressible embankment foundation using verticals and drains-application, design and construction method.

UNIT - III **9 Hours**

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 **9 Hours**

Use of special materials-geo-synthetics for drainage and in pavement layers. Use of reinforced earth retaining walls, Nailing Technique, Techniques of pavement construct ion using recycled materials–cold and hot mix recycling of bituminous materials. Design of pavements with geosynthetics as per IRC:SP:59

Soil stabilization – Types, materials, design and Construction of various stabilization techniques like lime, cement, bituminous and flyash.as per IRC:SP:89- Part 1 and 2

UNIT - V **9 Hours**

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.

References

1. R.M.Koerner “Designing with Geosynthetics”, - 4th Edition Prentice Hall, New Jerssey, 1997, ISBN-13: 978-0131454156, ISBN-10: 0131454153 Edition -4
2. IRC-75 “Guidelines for the design of High embankments”-IRC,1979
3. HMSO, Soil Mechanics for Highway engineers. DSIR–HMSO,London,1954, ISBN: 9780115502781, Edition - Edition -Volume-1

4. Leonards G.A "Foundation Engineering", -McGraw Hill Book Company, New York, 1962 ISBN-10: 0070371989; ISBN-13: 978-0070371989
5. Relevant IRC Codes and Guidelines

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)

CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component [20 (Q) + 40 (T) + 40 (EL) = 100 marks)

Sl.No.	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)

Q.NO.	CONTENTS	MARKS
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MHT323B4	**Intelligent Transportation System**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Program Specific Course-Elective B)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**

History of ITS, ITS – Need, Standards and policy, System architecture, ITS Developments – Worldwide and Indian scenario, Metropolitan and Rural ITS.
ITS User Services: Traffic Management centers - Types and functions, Travel and traffic management, Public transportation operations, Commercial vehicle operations.
Advanced Traveller Information Systems: Pre-trip and Enroute information, Data collection techniques, Route Guidance Systems, Infrastructure based systems and its applications, Variable message signs, Vehicle to Center and Vehicle to Road side communication.

UNIT - II	**9 Hours**

Sensor Technologies and Data requirements of ITS: Importance of telecommunications in the ITS system, Information Management, Traffic Management Centre (TMC). Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centre; Sensor plan and specification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts; ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), GIS, video data collection.

UNIT - III	**9 Hours**

ITS Functional Areas: Advanced Traffic Management systems (ATMS), Advanced Traveler Information systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control systems (AVCS), Advanced Public Transportation systems (APTS), Advanced Rural Transportation systems (ARTS). ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.

UNIT - IV	**9 Hours**

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

UNIT – V	**9 Hours**

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

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

CO1	:	Illustrate the Fundamental Concepts of ITS
CO2	:	Describe the various sensor technologies and data requirements of ITS
CO3	:	Apply ITS Architecture Frameworks
CO4	:	Describe the Key ITS applications and their Impact

References

1. Pradip Kumar Sarkar and Amit Kumar Jain, "Intelligent Transport Systems", PHI Learning Private Limited, Delhi,2018, , Edition-1, ISBN-9789387472068
2. Choudury M A and Sadek A, "Fundamentals of Intelligent Transportation Systems Planning" Artech House publishers (31 March 2003); ISBN-10: 1580531601
3. Bob Williams, "Intelligent transportation systems standards", Artech House, London, 2008. ISBN-13: 978-1-59693-291-3
4. Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola "Intelligent Transport Systems: Technologies and Applications" Wiley Publishing ©2015, Edition-1, ISBN:1118894782 9781118894781

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)

CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component [20 (Q) + 40 (T) + 40 (EL) = 100 marks)

Sl.No.	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)

Q.NO.	CONTENTS	MARKS
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MHT323B5	**Road Projects**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+ 30T	*(Program Specific Course-Elective B)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
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, identification of greenfield alignment, study of alternate alignments and bypasses, key acts related road projects	
UNIT - II	**9 Hours**
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, design of alignment – provision of tunnel in hilly terrain, Interpretation of survey results	
UNIT - III	**9 Hours**
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	**9 Hours**
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	**9 Hours**
Contract Documents and Tender Evaluation: preparation of BOQ, Types of tender documents, salient clauses of tender document, tender evaluation –technical and financial, Land acquisition process and preparation of LA plans, Value engineering	

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

CO1	:	Explain the components and need of project reports for proposed improvement of highway.
CO2	:	Interpret the data of different surveys and investigations required for various designs for road infrastructure.
CO3	:	Prepare different types of project reports required for feasibility assessment / execution of road projects.
CO4	:	Understand the contract / tender documents and evaluation process required for consultancy services and execution of roadworks.

References

1. IRC: SP:19 'Manual for Survey, investigation and Preparation of Road Project, 2020, 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, Indian Road Congress, New Delhi

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)

CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component [20 (Q) + 40 (T) + 40 (EL) = 100 marks)

Sl.No.	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)

Q.NO.	CONTENTS	MARKS
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MST324C1	**Design of Concrete Bridges**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*Theory*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Professional Cluster Elective - Group C)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Classification of Bridges, IRC Loading and vehicular load combinations, Impact factor. Partial safety factor for – verification of equilibrium, Structural strength and serviceability limit state. Design of RCC solid slab bridge.	
UNIT - II	**9 Hours**
Design of Box culverts. RCC T-Beam Girder & Slab Bridge: Transverse Analysis and Design, Longitudinal Analysis - Courbon method Ultimate Design for Long bending and Shear and Limit state of serviceability.	
UNIT - III	**9 Hours**
Grillage Analysis for T-Beam Girder super structure. Design of post tensioned PSC Girders - losses in prestressing, cable profile, end block design and ultimate strength design.	
UNIT - IV	**9 Hours**
Design of composite Girder Bridge -- Limit state of strength and Serviceability. Types of bearings and expansion joints.	
UNIT - V	**9 Hours**
Bridge Sub Structure and Foundation: Calculation of various forces on Substructure & Foundation as Per IRC, Methodology for design of substructure and foundation. Stability analysis of abutments and piers.	

Course Outcomes:

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

CO1	:	Explain the components of Highway Bridges & their specifications.
CO2	:	Analyse the IRC loading conditions for the design of bridges.
CO3	:	Design Aspects of RCC, PSC and Composite Bridge Super structure and understanding the types of Bridge Bearings and Expansion joints
CO4	:	Design Bridge Substructure by analyzing the forces acting on it.

References

1. Concrete Bridge Practice: Analysis, Design and Economics, V. K. Raina; Publisher, Tata McGraw Hill, 1991; Edition-1, ISBN, 0074603086, 978007460308,
2. Bridge Engineering, Ponnuswamy, McGraw-Hill Education (India) Pvt Limited, 2007, Edition-2, ISBN 0070656959, 9780070656956
3. Bridge Deck Behaviour, Hambly EC, December 12, 2019 by CRC Press, Edition-2, ISBN 9780367863425
4. Bridge Super Structure, N.Rajgopalan, Narosa Publishing House Pvt. Ltd., New Delhi, 2013,ISBN 13: 9788173196478. IRC CODES : IRC -6, IRC-112, IRC -24 , IRC -78.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MST324C2	**Design of Substructures**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Professional Cluster Elective - Group C)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Soil investigation: Importance of soil investigations, methods of soil investigation, Basic requirements of foundation, Types and selection of foundations. Concept of soil shear strength parameters, Settlement analysis of footings, Shallow foundations in clay, Shallow foundation in sand & C-Φ soils, Footings on layered soils and sloping ground Design for Eccentric or Moment Loads.	
UNIT - II	**9 Hours**
Shallow foundations: Bearing capacity of soil -plate load test, Design of reinforced concrete isolated, strip, combined and strap footings, mat foundation. Types of rafts, bearing capacity & settlements of raft foundation, Rigid methods, Flexible methods, soil-structure interaction.	
UNIT - III	**9 Hours**
Pile Foundations: Load Transfer in Deep Foundations, Types of Deep Foundations, Ultimate bearing capacity of different types of piles in different soil conditions, Laterally loaded piles, tension piles & batter piles, Pile groups: Bearing capacity, settlement, uplift capacity, load distribution between piles, Proportioning and design concepts of piles.	
UNIT - IV	**9 Hours**
Well foundations: Analysis of well foundations, Design principles, Well construction and sinking. Foundations for tower structures: Introduction, Forces on tower foundations, Selection of foundation type, Stability and design considerations, Ring foundations – general concepts.	
UNIT - V	**9 Hours**
Foundations in special cases: Foundation on expansive soils, under reamed pile foundation, Foundation for concrete Towers, chimneys, Reinforced earth retaining walls, Machine foundations and basic principles of design of machine foundation.	

Course Outcomes:

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

CO1	:	Achieve Knowledge of interpreting the investigated data and design appropriate foundation system.
CO2	:	Identify and evaluate the soil shear strength parameters, bearing capacity for various sub-soil profiles and loading conditions.
CO3	:	Evaluate the behavior of structures subjected to various loading and ground conditions.
CO4	:	Analyse and design shallow foundation, deep foundations and special foundations depending on the type of soil and loading.

References

1. Analysis & Design of Substructures, Swami Saran, Oxford & IBH Pub. Co. Pvt. Ltd., 2006, Edition-2, ISBN:434- 238-1343.
2. Foundation Design, W.C. Teng, Prentice Hall of India Pvt. Ltd, 2003, ISBN:234-456-12343.
3. Foundation Engineering, R.B. Peck, W.E. Hanson & T.H. Thornburn, Second Edition, Wiley Eastern Ltd., 1984, Edition-2, ISBN:2285-064-12328.
4. Foundation Analysis and Design, J.E. Bowles, Fifth Ed., McGraw-Hill Int. Editions, 2008, Edition-5, ISBN:745- 873-12854.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MST324C3	**Prestressed and Precast Concrete Elements**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Professional Cluster Elective - Group C)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**

Introduction to Precast structures: Concept of precast, precast products, standardization, precast accessories, types of precast constructions, methodologies, equipment and machineries, economy of prefabrication, Planning for Components of prefabricated structure, Disuniting of structures. Advantages and Disadvantages, Applications. Prestressed Precast Concrete Panels for buildings, pavements, industrial floors. Introduction to prestressed concrete: Historic development- general principles of Prestressing, Types of pre stressing, pre-tensioning and post tensioning, advantages and limitation of prestressed concrete, Materials for pre stressed concrete- high strength steel and concrete, properties, Stress-strain characteristics of high strength steel and concrete Codal Provisions: Basic principles of pre stressing, fundamentals of prestressing, Load balancing concept, Stress concept, center of thrust, Pretensioning and post tensioning methods-Analysis of post tensioning, Systems of pre stressing, End anchorages.

UNIT - II	**9 Hours**

Analysis of sections for Flexure: Elastic analysis of pre stressed concrete beams with straight, parabolic, triangular, trapezoidal cable profiles, Eccentric and concentric pre stressing, Analysis of members at ultimate strength, Numerical problems

Shear and Torsional resistance of PSC sections- ultimate shear resistance, Design of Sections for Shear - Shear and Principal stresses - Improving shear resistance by different prestressing Techniques, Design of shear reinforcement - Indian code provisions, Design of shear reinforcement in torsion.

UNIT - III	**9 Hours**

Losses in Pre stress: Loss of Pre stress due to Elastic shortening, Friction, Anchorage slip, Creep of concrete, Shrinkage of concrete and Relaxation of steel - Total Loss.

Deflection: Deflection due to gravity loads - Deflection due to prestressing force -Total deflection - Limits of deflection - Limits of span-to-effective depth ratio.

UNIT - IV	**9 Hours**

Composite sections of prestressed concrete beam and cast in situ RC slab analysis of stresses differential shrinkage deflections Flexural and shear strength of composite sections Design of composite sections.

Transfer of Prestress in Pretensioned Members: Transmission of prestressing force by bond Transmission length , Flexural bond stresses - IS code provisions - Anchorage zone stresses in post tensioned members - stress distribution in End block - Analysis by approximate, Guyon and Magnel methods -Anchorage zone reinforcement

UNIT - V	**9 Hours**

Statically indeterminate Structures: Advantages & disadvantages of continuous Prestressed beams - Primary and secondary moments - P and C lines - Linear transformation concordant and non-concordant cable profiles -Analysis of continuous beams and simple portal frames (single bay and single story)

Course Outcomes:

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

CO1	:	Identify various prestressed structural elements & understand concept of precast concrete
CO2	:	Apply analytical skills to evaluate performance of prestressed structural elements
CO3	:	Analyze prestressed structural elements with various considerations.
CO4	:	Design and detail prestressed structural elements for various loading conditions.

References
1. Prestressed Concrete, N Krishnaraju, Tata McGraw- Hill Education, 2008, Edition-6, ISBN0070634440, 9780070634442.
2. Prestressed Concrete structures, Lin T. Y and H. Burns, 2009, Wiley Publication, Edition-3, ISBN: 978-0-471 01898-8
3. Prestressed Concrete, N. Rajagopalan, 2nd Edition,2005, Narosa Publishing House.ISBN 2053 2005.
4. Design of Prestressed Concrete, A. Nilson, 2nd edition, John Willey & Sons., ISBN 1765 1997.
5. Precast concrete structures, Hubert Bachmann and Alfred Steinle' First edition,2011, Ernst &Sohn, GmbH &Co., ISBN978-3-433-60096-2

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MST324C4	**Reliability Based Analysis in Civil Engineering**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Professional Cluster Elective - Group C)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Probability mass function, probability density function, mathematical expectation, Chebyshev's theorem. Probability distributions: discrete distributions- Binomial and Poisson distributions, continuous distributions-Normal, Lognormal distributions.	
UNIT - II	**9 Hours**
Measures of reliability-factor of safety, safety margin, reliability index, performance function and limiting state. Reliability analysis-first order second moment method (FOSM), Point Estimate method (PEM).	
UNIT - III	**9 Hours**
Evaluation of reliability by First Order Second Moment method (Hasofer-Lind's method).	
UNIT - IV	**9 Hours**
Simulation Techniques: Monte Carlo simulation- statistical experiments, confidence limits, sample size and accuracy, generation of random numbers- random numbers with standard uniform distribution, continuous random variables, discrete random variables, Evaluation of reliability.	
UNIT - V	**9 Hours**
System Reliability of series, parallel and combined systems, evaluation of probability of survival for determinate and redundant structural system.	

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

CO1	:	To model uncertainty of variables by probability distributions.
CO2	:	To assess level of safety by reliability analysis for the various performance functions.
CO3	:	To generate random numbers by simulation method.
CO4	:	To assess safety level at component and system level.

References

1. Structural Reliability Analysis and Design, Ranganathan, R, 2000, Jaico Publishing House, Mumbai, India, Edition-1, ISBN81-7224-851-2.

2. Reliability based Analysis and Design for Civil Engineers, Devaraj. V & Ravindra. R, 2017, I.K.International Publishing House Pvt.Ltd, India, Edition-1, ISBN 978-93-85909-80-1.

3. Probability Concepts in Engineering Planning and Design, Volume –I & II, Ang, A. H. S., and Tang, W. H., 1984, John Wiley and Sons, Inc, New York.ISBN10-047103200X, ISBN13-978-0471032007.

4. Probability, Reliability and Statistical Methods in Engineering Design, Achintya Haldar and Sankaran Mahadevan ,2000, Wiley, ISBN10-8126567783.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 &10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MHT324C5	**Urban and Regional Planning**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Professional Cluster Elective - Group C)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Basic Concepts Policies and Programmes: Definitions and Concept- Urbanization, Towns, Cities, Metropolis, Megalopolis, Satellite and New towns, CBD, Suburban areas, Census Definition, Classification of urban settlements, TOD, National policies, National Urban Transport Policy 2014, National Policy for Urban street vendors 2014, Smart Cities Mission, and AMRUT (Atal Mission for Rejuvenation and Urban Transformation)	
UNIT - II	**9 Hours**
Planning Process: Steps in Planning Process- Plans; levels; objectives, content, and data requirement-regional plan, master plan, detail development plan, city development plan, development control regulation, Zoning Regulation, Layout and Building Regulations.	
UNIT - III	**9 Hours**
Socio Economic and Spatial Planning: Economic and social concepts in urban and regional planning and their relevance, Economic principals of zoning, Components of sustainable development, Inclusive development, Compact cities, Quality of life-Form of cities, issues related to inner city fringe areas, and suburban areas, Application of Remote sensing and GIS in Urban and Regional planning.	
UNIT - IV	**9 Hours**
Project Formulation and Evaluation: Constraints for plan implementation – Industrial, Financial and Legal Constraints, Institutional Arrangements for Urban Development – Financing of Urban Developments - Legislation related to Urban Development. Urban infrastructure projects planning, appraisal, formulation, feasibility and preparation of detailed project report, site planning, layout, road network, and service ducts under the road, Environmental impact assessment, and Traffic assessment	
UNIT - V	**9 Hours**
Urban Governance and Management: Planning laws; Town and Country planning act: Urban Development authorities Act, Constitutional (74th Amendment) Act 1992- Local bodies, Functions, powers and Interfaces. Principles of Sustainable Urban Transport and Climate-Resilient Transport Infrastructure and its impacts.	

Course Outcomes:

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

CO1	:	Explain urbanization concepts and policies to improve urban life
CO2	:	Outline planning steps and apply zoning to support organized city growth
CO3	:	Assess socio-economic factors and apply tools for spatial planning, promoting balanced urban development.
CO4	:	Evaluate projects within legal and financial limits and understand urban laws for compliance

References

1. Edwin S.Mills and Charles M.Becker, "Studies In Urban Development", A World Bank Publication, 1986, ISBN – 13 978-0195205077
2. Tumlin Jeffrey, "Sustainable Transportation Planning Tools for Creating Vibrant Healthy and Resilient Communities", John Wiley And Sons, 2012, ISBN: 978-0-470-54093-0

3. Peter Hall, Peter Hall, Mark Tewdwr-Jones "Urban and Regional Planning"6th Edition, Routledge-Taylor and Francis publications, year 2019, ISBN 9780815365303
4. J. Brian McLoughlin, "Urban and Regional Planning: A Systems Approach", Rawat Publications,2019, Edition-1, ISBN 9788131610053.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 &10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MHT324C6	**Logistics in Transportation Engineering**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Professional Cluster Elective - Group C)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Introduction to Logistics and Supply Chain Management: Overview of Logistics and Supply Chain Management**,** Key Elements of Logistics System, Logistics in Transportation Engineering	
UNIT - II	**9 Hours**
Freight Transport: Freight Costs – Freight Demand Models, Econometric Models for Freight Forecasting – Input Output Models – Regional Network Systems.	
UNIT - III	**9 Hours**
Distribution Management: Supply Chain – Warehousing – Facility Location, Inventory – Mode Choice – Distribution System, Vehicle Routing and Scheduling	
UNIT - IV	**9 Hours**
Logistics Management: Logistics out sourcing – IT Application in Freight Logistics – Technology in Logistics Management – Intermodal Transportation Technologies in Transportation Logistics: GPS, GIS, and Intelligent Transportation Systems (ITS) applications in logistics	
UNIT - V	**9 Hours**
Emerging Trends and Case Studies in Transportation Logistics: Sustainable and Green Logistics, Digital Transformation in Logistics-IoT, big data analytics, AI, and blockchain in logistics management. Case Studies and Real-World Applications: Case studies on logistics and transportation from various sectors. Analysis of successful logistics systems and lessons learned.	

Course Outcomes:

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

CO1	:	Explain the fundamental concepts of logistics and supply chain concepts to manage and improve transportation networks efficiently
CO2	:	Analyze factors influencing logistics and transportation decisions to develop optimized, cost-effective solutions for real-world scenarios
CO3	:	Apply inventory, warehousing, and routing principles to enhance logistics operations and ensure effective resource management in transportation systems
CO4	:	Evaluate emerging trends and technologies in logistics to adopt sustainable and innovative practices for modern transportation challenges

References

1. Blanchard S.Benjamen, "Logistics Engineering and Management", Prentice Hall, Inc, Eaglewood Cliffs, New Jersey 07632, 1986, ISBN 10: 0135400880, Edition-5, ISBN 13: 9780135400883

2. Supply Chain Management – Strategy, Planning & Operation, Sunil Chopra, Peter Meindl & D V Kalra, 6th Edition, 2016, Pearson Education Asia; ISBN: 978-0-13-274395-2.

3. Khanna K.K., "Physical Distribution Management", Logistical Approach, Himalaya Publishing House, Bombay, 1985, Edition-1, ISBN. 978-93-5202

4. Supply Chain Management – Creating Linkages for Faster Business Turnaround, Sarika Kulkarni & Ashok Sharma, 1st Edition, 2004, TATA Mc Graw Hill, ISBN: 0-07-058135–5

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MBT325DA	**Nature Impelled Engineering**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	45L+45EL	*Elective D (Interdisciplinary Elective)*	SEE Durations	:	3 Hr

UNIT - I **9 Hrs**

Bio-Inspired designs-biomimetics: Termites; Sustainable buildings, Insect foot adaptations for adhesion. Bees and Honeycomb Structure. Namib Desert Beetle; Harvesting desert fog- Nature's water filter. Biopolymers, Bio-steel, Bio-composites, multi-functional biological materials. Antireflection and photo-thermal biomaterials, Invasive and non-invasive thermal detection inspired by skin.

UNIT - II **9 Hrs**

Plant inspired Technologies: Photosynthesis and Photovoltaic cells, Bionic/Artificial leaf. Lotus leaf effect for super hydrophobic surfaces. Flectofin®, a new façade-shading system inspired by flower of the Bird-of-Paradise (Strelitzia reginae). Robotic Solutions Inspired by Plant Root.

UNIT - III **9 Hrs**

Bio-Inspired technologies for medical applications: Organ system- Circulatory- artificial blood, artificial heart, pacemaker. Respiratory- artificial lungs. Excretory- Artificial kidney and skin. Artificial Support and replacement of human organs: artificial liver and pancreas. Total joint replacements- artificial limbs. Visual prosthesis -artificial / bionic eye.

UNIT - IV **9 Hrs**

Bio-Inspired driven technologies for industrial applications: Biosensors: Artificial tongue and nose. Biomimetic echolation. Insect foot adaptations for adhesion. Thermal insulation and storage materials. Bio-robotics.

UNIT - V **9 Hrs**

Bio-inspired computing: Cellular automata, neural networks, evolutionary computing, swarm intelligence, artificial life, and complex networks. Genetic Algorithms, Artificial Neural Networks. Artificial intelligence and MEMS.

Course Outcomes:

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

CO1	:	Contemplate a deep understanding of biological systems, mimetics structures, and functions that inspire engineering innovations for adaptability and sustainability.
CO2	:	Endeavor biological principles from nature driven techniques to design engineering systems for solving real-world challenges
CO3	:	Appraise the bioinspired materials for their advanced applications in the domain of health, energy and environmental sustainability.
CO4	:	Paraphrase biomimicry and ethics in bioinspired engineering designs, ensuring that their solutions are environmentally responsible and socially conscious

References:

1. Yoseph Bar-Cohen. Biomimetics: Biologically Inspired Technologies D. Floreano and C. Mattiussi, "Bio-Inspired Artificial Intelligence", CRC Press, 2018. Edition-1 ISBN: 1420037714, 9781420037715.
2. Guang Yang, Lin Xiao, and Lallepak Lamboni. Bioinspired Materials Science and Engineering. John Wiley, 2018. Edition-1 , ISBN: 978-1-119-390336.
3. M.A. Meyers and P.Y. Chen. Biological Materials, Bioinspired Materials, and Biomaterials Cambridge University Press, 2014, Edition-1 , ISBN 978-1-107-01045.
4. Tao Deng. Bioinspired Engineering of Thermal Materials. Wiley-VCH Press, 2018. Edition-1 , ISBN: 978-3-527-33834-4.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MBT325DB	**CLINICAL DATA MANAGEMENT**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	45L+45EL	*Elective G* *(Interdisciplinary Elective)*	SEE Durations	:	3 Hrs

UNIT - I	**9 Hrs**
Fundamentals of Healthcare Data and Analytics: Overview, importance, and evolution of health informatics in the digital age, Healthcare Data Types: Structured vs. unstructured data, clinical vs. operational data, and sources of healthcare data, Data Conversion and Integration: Data standardization, integration into clinical data warehouses, and data cleaning. Data Analytics: Introduction to descriptive, predictive, and prescriptive analytics in healthcare. Use of AI and machine learning for improved outcomes, Challenges and Future Trends: Data privacy, interoperability issues, the role of informatics in personalized medicine, and the future of digital health.	
UNIT - II	**9 Hrs**
Electronic Health Records (EHRs) and Digital Health: Overview of EHRs: Key components, data capture mechanisms, and the shift towards integrated EHR systems. Scope and Adoption: Role of EHRs in enhancing patient care, interoperability, and data sharing between healthcare providers. Implementation Process: Steps for selecting, deploying, and optimizing EHR systems, including vendor selection and compliance with healthcare regulations. Challenges in EHRs: Usability issues, data quality, resistance to adoption, and strategies for overcoming these barriers. Digital Health Innovations: Impact of telemedicine, remote patient monitoring, and digital therapeutics on EHR integration.	
UNIT - III	**9 Hrs**
Data Standards, Interoperability, and Medical Coding: Introduction to Standards: Need for data standards in health informatics, and their role in ensuring interoperability. Terminology and Content Standards: Deep dive into ICD, SNOMED CT, LOINC, and HL7 FHIR. Data Exchange and Transport Standards: HL7, DICOM, CDA, and emerging standards for seamless data exchange. Medical Coding Systems: Role of medical coding in billing, clinical documentation, and outcome measurement. Overview of CPT, ICD-10, and DRG codes. Emerging Trends: Role of AI in medical coding and billing, and the shift towards real-time data standardization.	
UNIT - IV	**9 Hrs**
Health Informatics Ecosystem: Introduction to the ecosystem, including hospitals, clinics, insurance providers, and regulatory bodies. Key Players and Stakeholders: Role of informatics professionals, data scientists, clinicians, and IT staff in healthcare. Challenges and Barriers: Addressing technical, organizational, and regulatory challenges in health informatics. Career Opportunities: Overview of roles like clinical informatics specialist, health data analyst, and telehealth coordinator. Resources and Professional Development: Important certifications, online resources, and organizations (e.g., HIMSS, AMIA).	
UNIT - V	**9 Hrs**
Health Information Privacy, Security, and Ethics: Introduction to Privacy and Security: Core principles of data privacy, HIPAA, and GDPR in healthcare. Security Principles: Confidentiality, integrity, availability, encryption methods, and access control mechanisms. Authentication and Identity Management: Role of biometric authentication, two-factor authentication, and secure access protocols. Data Security in the Cloud: Cloud computing in healthcare, managing risks in cloud-based data storage, and hybrid cloud models. Ethics in the use of AI in healthcare, managing bias in algorithms, and ensuring equitable access to digital health technologies.	

Course Outcomes: After going through this course the student will be able to:		
CO1	:	Understand the key principles and challenges of health informatics, and apply them to real-world scenarios.
CO2	:	Effectively manage the process of data capture, conversion, and analysis to generate actionable insights.
CO3	:	Apply knowledge of medical coding, data standards, and interoperability to improve data sharing and clinical workflows.
CO4	:	Implement robust security measures to protect patient data, and navigate ethical issues in health informatics.

References:

1. Robert E. Hoyt Ann K. Yoshihashi, Health Informatics, Practical guide for Healthcare and Information Technology Professionals, 6th edition, Informatics Education, 2014, ISBN: 978-0-9887529-2-4
2. Kathryn J. Hannah Marion J. Ball, Health Informatics, Springer Series edition, Springer, 2005, ISBN: 1-85233-826-1
3. William R Hersh, Health Informatics, a Practical guide, 8th edition. 2022, ISBN 978-1-387-85475-2
4. Pentti Nieminen. Medical informatics and data analysis 1st edition, MDPI AG, 2021, ISBN-13: 978-3036500980

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)

CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**

Sl.No.	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MCN325DC	**Cyber Forensics and Cyber Laws**	CIE Marks	:	100
Credits L-T-P	:	3-0-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL	*(Interdisciplinary Cluster Course-D)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Computer Forensics in Today's World Introduction to Computer Forensics and Digital Evidence, the Role of the Forensic Investigator, Understanding Forensic Readiness. Legal Issues and Considerations, Types of Computer Forensic Investigations, Forensic Investigation Process.	
UNIT - II	**9 Hours**
Investigation Process Computer Forensics Investigation Methodology, Handling Digital Evidence, Chain of Custody and Documentation, Evidence Preservation: Hashing and Imaging, Investigation Planning and Legal Approval, Searching and Seizing Computers: Search and Seizure Procedures, obtaining a Search Warrant, Securing the Crime Scene	
UNIT - III	**9 Hours**
Digital Evidence Types of Digital Evidence (Physical, Logical, Latent), Collecting and Preserving Digital Evidence, Writing Reports on Digital Evidence, Identifying Evidence Sources: Hard Drives, Network Logs, Databases, Evidence Recovery Techniques, First Responder Procedures: First Responder Role in Digital Investigations, Protecting and Securing Evidence, Best Practices for Incident Response	
UNIT - IV	**9 Hours**
Jurisdiction of Cyberspace Information Technology Law Literature and Glossary, Inform ation Technology Law Concepts, Jurisdictional Issues in Cyber Space, scope of I.T. laws, Law and the Internet: Domain issues in Internet, Regulatory body, ICANN regulations	
UNIT - V	**9 Hours**
Security Governance Objectives Security Architecture, Risk Management Objective, Developing A Security Strategy, Sample Strategy Development	

Course Outcomes:

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

CO1	:	Gain a comprehensive understanding of Cyber forensic and Investigation
CO2	:	Apply cyber forensics measures, tools, and techniques to protect systems, networks, and information.
CO3	:	Analyze the Legal Frameworks governing the internet
CO4	:	Exploration of Security Frameworks in the Cyber space.

References
1. EC-Council CHFI Course Outline: https://www.eccouncil.org/programs/computer-hacking-forensic-investigator-chfi/
2. Guide to Computer Forensics and Investigations" by Bill Nelson, Amelia Phillips, and Christopher Steuart, 6th Edition (latest), Cengage Learning, February 15, 2018, 978-1337568944
3. 3. The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics" by John Sammons, Edition: 2nd Edition (latest) Syngress (an imprint of Elsevier), June 30, 2014, ISBN-10: 0128016353

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MCV325DD	**Industrial Safety and Health**	CIE Marks	:	100
Credits L-T-P	:	3-0-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL	*Interdisciplinary Cluster course -D*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure. National Policy and Legislations on EHS in India - Regulations and Codes of Practice - Role of trade union safety representatives. Occupational health and safety: Introduction: Health, Occupational health: definition, Interaction between work and health, Health hazards, workplace, economy and sustainable development. Development of accident prevention programs and development of safety organizations.	
UNIT - II	**9 Hours**
Work as a factor in health promotion. 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 Hours**
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	**9 Hours**
Occupational safety and Health act. Occupational Safety and Health Administration, right to know Laws, Accident Causation, Correcting Missing Skills, Investigator Tendencies and Characteristics, Theories of accident causation: Domino theory, Human Factors theory, Accident/Incident theory, Epidemiological theory and systems theory of accident causation.	
UNIT - V	**9 Hours**
Environmental Health and Safety Management: Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and implementation and review – ISO 45001-Structure and Clauses-Case Studies. Occupational Health and Safety Considerations: Water and wastewater treatment plants, Construction material manufacturing industries like cement plants, RMC Plants, precast plants and construction sites, Municipal solid waste management.	

Course Outcomes:
After going through 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	:	Exposure to the onset of regulatory acts and accident causation models.
CO4	:	Demonstrate the significance of safety policy, models and safety management practices.

References

1. Industrial Health and Safety Acts and Amendments, by Ministry of Labor and Employment, Government of India.
2. Fundamentals of Industrial Safety and Health by Dr.K.U.Mistry, Siddharth Prakashan, 2012.
3. Goetsch, D. L. (2011). Occupational Safety and Health for Technologists, Engineers and Managers 3rd edition,Prentice hall, ISBN-13: 978-0-13-700916-9 ISBN-10: 0-13-700916-X
4. David. A. Calling - Industrial Safety Management and Technology, Prentice Hall, New Delhi, ISBN-10 : 0134572351 ISBN-13 : 978-0134572352
5. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995, ISBN 0815517068, 9780815517061.
6. ISO 45001:2018 Occupational health and safety management systems – Requirements with guidance for use, International Organisation for Standardisation, Edition-1, 2018.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)

CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component [20 (Q) + 40 (T) + 40 (EL) = 100 marks)

Sl.No.	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)

Q.NO.	CONTENTS	MARKS
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MCV325DE	**Advanced Technologies for Transportation Systems**	CIE Marks	:	100
Credits L-T-P	:	3-0-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL	*(Interdisciplinary Cluster Course-D)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Introduction to Intelligent Transportation Systems (ITS): Definition, objectives, Historical Background, Benefits of ITS –ITS. ITS User Services. ITS Applications. Strategic Needs Assessment and Deployment. Regional ITS Architecture Development Process. ITS Standards. ITS Evaluation. ITS Challenges and Opportunities.	
UNIT - II	**9 Hours**
Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection. Telecommunications in ITS: Information Management, Traffic Management Centres (TMC). Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centres; Sensor plan and specification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts.	
UNIT - III	**9 Hours**
Traffic Engineering - Fundamental relations of traffic flow, Traffic Stream models - , Shock wave, Car following models, Lane changing models, Vehicle arrival models, PCU values, Interrupted and Uninterrupted flow. Signalized intersection design and Analysis based on IRC, HCM and Indo –HCM. Numerical Problems. Traffic Simulation. Numerical Problems. Application of IOT, Machine learning in traffic management.	
UNIT - IV	**9 Hours**
Transportation Network Analysis – Basic Introduction to Travel demand modelling, Trip generation, Distribution, Modal Split and Trip Assignment. Transit Capacity, ITS functional areas: Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS)	
UNIT - V	**9 Hours**
ITS applications: Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing. Parking Management; Transportation network operations; commercial vehicle operations; public transportation applications; Automated Highway Systems- Vehicles in Platoons –ITS in World – Overview of ITS implementations in developed countries, ITS in developing countries. Case Studies	

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

CO1	:	Identify and apply ITS applications at different levels
CO2	:	Illustrate ITS architecture for planning process
CO3	:	Examine the significance of ITS for various levels
CO4	:	Compose the importance of ITS in implementations

References
1. Pradip Kumar Sarkar and Amit Kumar Jain, "Intelligent Transport Systems", PHI Learning Private Limited, Delhi,2018, ISBN-9789387472068
2. Choudury M A and Sadek A, "Fundamentals of Intelligent Transportation Systems Planning" Artech House publishers (31 March 2003); ISBN-10: 1580531601
3. Bob Williams, "Intelligent transportation systems standards", Artech House, London, 2008. Edition-1, ISBN-13: 978-1-59693-291-3
4. Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola "Intelligent Transport Systems: Technologies and Applications" Wiley Publishing ©2015, Edition-1 , ISBN:1118894782 9781118894781

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5& 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

Semester: II						
Course Code	:	MEC325DF	**Design and Implementation of Human-Machine Interfaces** *Industry Assisted Elective-Bosch*	CIE	:	100 Marks
Credits: L:T:P	:	3:0:0	*(Theory)*	SEE	:	100 Marks
Total Hours	:	45L+45EL	*(Interdisciplinary Cluster Course-D)*	SEE Duration	:	3Hours

Unit-I	**09 Hrs**
Foundations of HMI: The Human: History of User Interface Designing, I/O channels, Hardware, Software and Operating environments, The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning and problem solving. The computer: Devices, Memory, processing and networks. Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms. Introduction to HMI and domains: Automotive, Industrial, CE, Medical, ECUs within car and their functionalities. Interaction between ECUs. Communication protocols for ECUs(CAN, LIN, Most, FlexRay, Ethernet etc)	
Unit – II	**09 Hrs**
Automotive Human-Machine Interfaces: Automotive infotainment system - Evolution road map, Feature sets, System architecture, Trends, Human factors and ergonomics in automotive design, Automotive User Experience (UX) Design Principles, In-Vehicle Information Systems (IVIS), Driver-Assistance Systems (DAS) Interfaces, HMI design for adaptive cruise control, Voice and Gesture Recognition in Automotive HMIs, Touchscreen Interfaces and Controls, Usability Testing and Evaluation in Automotive HMIs, Safety Considerations and Regulations in Automotive HMIs, Emerging Technologies in Automotive HMIs, Human-Machine Interfaces for Autonomous Vehicles	
Unit –III	**09 Hrs**
UX and Guidelines: Introduction to UX design - stages, theory, Design thinking, UX Study, Interaction concepts, Graphic design tools - Adobe Photoshop, Adobe XD, Blender, GIMP, Asset Design - Overview , Guidelines and norms, 2D/3D rendering, OpenGL, OSG.	
Unit –IV	**09 Hrs**
HMI User Interface: User-centered HMI development process, Basics of Web-Server. Web-based HMI: Basics of TwinCAT and HTML, CSS, JavaScript. HMI on Mobile: Four Principles of Mobile UI Design, Benefits of Mobile HMIs, Mobile HMI Development Suites.	
Unit –V	**09 Hrs**
HMI Control Systems: Introduction to Voice-Based HMI, Gesture-Based HMI, Sensor-Based UI controls. Haptics in Automotive HMI: Kinesthetic Feedback Systems, Tactile Feedback Systems, Haptics in Multimodal HMI, Automotive Use-Cases HMI Testing: Limitations of Traditional Test Solutions, Case - Study: Bosch's HMI validation tool - Graphics Test Systems (GTS). UI analytics: Usage patterns, Debugging, Performance Profiling, Use Cases.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Explain the application of HMIs in various domain
CO2	Differentiate various communication protocols used in HMI development.
CO3	Describe car multimedia system and hardware and software evolution.
CO4	Use various graphic tools and advanced techniques to create UIs

References	
1.	Shuo gao, Shuo Yan, Hang Zhao, Arokia Nathan " Touch based HMI; Principles and Applications" Springer Nature Switzerland AG, 1st Edition.
2.	Robert Wells, " Unity 2020 by Example: A Project based guide to building 2D, 3D augumented reality and Virtual reality games from sratch" Packt Publishing ltd , edition 2020
3.	Ryan Cohen, Tao Wang, "GUI Design and Android Apps" Apress, Berkley, CA,2014

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MEE325DG	**ELECTRIC VEHICLE TECHNOLOGY**	CIE Marks	:	100
Credits L-T-P	:	3-0-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL	*(Interdisciplinary Cluster Course-D)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
History, Basics of Electric Vehicles, Components of Electric Vehicle, General Layout of EV, EV classification: Battery Electric Vehicles (BEVs), Hybrid Electric Vehicle (HEV), Fuel-Cell Electric Vehicles (FCEVs) Comparison with Internal Combustion Engine: Technology, Advantages & Disadvantages of EV, National Policy for adoption of EVs.	
UNIT - II	**9 Hours**
Electric Drive-Trains: Introduction to various electric drive-train topologies in EV and HEV, Power flow control in electric drive-train topologies, classification of electric machines used in automobile drivetrains. E-Motor Drives Configuration (Control Block diagrams): Induction Motor Drive, Permanent Magnet (PM) motor Drive & Switched Reluctance Motor (SRM) Drive.	
UNIT - III	**9 Hours**
Battery Energy Storage: Types of Battery, Introduction to Electrochemical Battery, Electrochemical Reactions, Battery Parameters: Battery Capacity, Discharge Rate, Charging Rate, SOC, SOD, SOH, DOD, Specific Energy, Specific Power, Energy Efficiency, Battery Management Systems (BMS): Introduction to BMS, Objectives of the BMS: Discharging control, Charging control, Cell Balancing; BMS topologies: Distributed Topology, Modular Topology and Centralized Topology.	
UNIT - IV	**9 Hours**
Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage, Fuel Cell based energy storage, Super Capacitor based energy storage, Hybridization of different energy storage devices. Introduction to BMS and its topologies. Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, Classification of different energy management strategies, Comparison of different energy management strategies and implementation issues of energy management strategies.	
UNIT - V	**9 Hours**
Charging Infrastructure: Basic Requirements for Charging System, Charger Architectures, Grid Voltages, Frequencies, and Wiring, Charging Standards and Technologies, SAE J1772. On-board chargers and Off-board chargers, Topologies and Standards, Types of Charging Station Charging Station Placement for Electric Vehicles: A Case Study.	

Course Outcomes:

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

CO1	:	Analyse the basics of electric and hybrid electric vehicles, their architecture, technologies and modelling.
CO2	:	Analyse various electric drives suitable for electric vehicles.
CO3	:	Discuss and implement different energy storage technologies used for electric vehicles and their management system.
CO4	:	Analyse various charging methods, requirements, standards and types of charging for EV and HEV.

References
1. Modern Electric Vehicle Technology C.C. Chan and K.T. Chau, 1st Edition, 2001, Oxford university press, ISBN 0 19 850416 0.
2. Battery Management system for large Lithium Battery Packs, Davide Andrea, 1st Edition, 2010, ARTECH HOUSE, ISBN-13 978-1-60807-104-3.
3. Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, 1st Edition, 2018, Wiley, ISBN 9781119063667.
4. Hybrid Vehicles from Components to System, F. BADIN, Ed, 1st Edition, 2013, Editions Technip, Paris, ISBN 978-2-7108-0994-4.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MET325DH	**Electronic Navigation Systems**	CIE Marks	:	100
Credits L-T-P	:	3-0-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL	*(Interdisciplinary Cluster Course-D)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
An Introduction to Radar: Basic Radar, The simple form of the Radar Equation, Radar Block Diagram, Radar Frequencies, Application of radar, Types of Radars. Detection of signals in Noise, Receiver Noise and the Signal-to Noise Ratio, Probability of Detection and False alarm, Introduction to Doppler, MTI, UWB Radars	
UNIT - II	**9 Hours**
Terrestrial Network based positioning and navigation: General Issues of wireless positions location, Fundamentals, positioning in cellular networks, positioning in WLANs, Positioning in Wireless sensor networks.	
UNIT - III	**9 Hours**
Satellite-based navigation systems: Global Navigation satellite systems (GNSS), GNSS receivers.	
UNIT - IV	**9 Hours**
LiDAR: Introduction to LiDAR, context and conceptual discussion of LiDAR, Types of LiDARS, LiDARS Detection modes, Flash LiDAR versus Scanning LiDAR, Monostatic versus Bistatic LiDAR, Major Devices in a LiDAR, LiDAR remote sensing, Basic components and physical principles of LiDAR, LiDAR accuracy and data formats.	
UNIT - V	**9 Hours**
SONAR: Underwater acoustics, applications, comparison with radar, submarine detection and warfare, overcoming the effects of the ocean, sonar and information processing. Transmission of the acoustic signal: Introduction, detection contrast and detection index, transmission equation, equation of passive and active sonar.	

Course Outcomes:

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

CO1	:	Understand the concepts of Radar, LiDAR, Sonar, terrestrial and satellite based navigation system.
CO2	:	Apply the concepts of radars, LiDAR, Sonar, cellular networks, WLAN, sensor networks and satellites in determining the user position and navigation.
CO3	:	Analyze the different parameters of satellite and terrestrial networks for navigation systems.
CO4	:	Evaluate the Radar, LiDAR, Sonar systems and satellite and terrestrial network based navigation and tracking systems.

References

1. M. L Skolnik, Introduction to RADAR Systems,3rd edition, 2017,TATA Mcgraw-Hill, ISBN: 978-0070445338
2. Mark A Richards, James A Scheer, William A Holam, Principles of Modern Radar Basic Principles, 2010, 1st edition, SciTech Publishing Inc, ISBN:978-1891121524 .
3. Davide dardari, Emanuela Falletti, Marco Luise, Satellite and Terrestrial Radio Positioning techniques- A signal processing perspective, 1st Edition, 2012, Elsevier Academic Press, ISBN: 978-0-12-382084-6.
4. Paul McManamon, LiDAR Technologies and Systems, SPIE press, 2019. ISBN 9781510625396
5. Pinliang Dong and Qi Chen, LiDAR Remote Sensing and Applications, CRC Press, 2018, Edition-1 , ISBN: 978-1- 4822-4301-7
6. Jean-Paul Marage, Yvon Mori, Sonar and Underwater Acoustics, Wiley, 2013, Edition-3 ISBN: 9781118600658

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MET325DJ	**Vehicular Communication Ecosystem**	CIE Marks	:	100
Credits L-T-P	:	3-0-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL	*(Interdisciplinary Cluster Course-D)*	SEE Duration	:	3 Hours

UNIT - I **9 Hours**

Introduction: Basic Principles and Challenges, Past and Ongoing VANET Activities
Standards and Regulations of DSRC
Introduction, Layered Architecture for VANETs, DSRC Regulations, DSRC Physical Layer Standard, DSRC Data Link Layer Standard (MAC and LLC), DSRC Middle Layers.

UNIT - II **9 Hours**

Physical Layer Considerations for Vehicular Communications: Standards Overview, Wireless Propagation Theory, Channel Metrics, Measurement Theory, Empirical Channel Characterization at 5.9 GHz.
MAC Layer and Scalability Aspects of Vehicular Communication Networks: Challenges and Requirements. MAC Approaches for VANETs, Communication Based on IEEE 802.11p.

UNIT - III **9 Hours**

MAC Layer and Scalability Aspects of Vehicular Communication Networks Performance Evaluation and Modeling, Aspects of congestion control.
Data Security in Vehicular Communication Networks: Challenges of Data Security in Vehicular Networks, Network, Applications, and Adversarial Model, Security Infrastructure, Cryptographic Protocols.

UNIT - IV **9 Hours**

Intra-vehicle communication:-In-vehicle networks, Automotive bus systems, In-vehicle Ethernet, Wireless in-vehicle networks
Inter-vehicle communication: Applications, Requirements and components, Concepts for inter-vehicle communication, Fundamental limit.

UNIT - V **9 Hours**

Cooperative Vehicular Safety Applications: Introduction, Enabling technologies, Cooperative system architecture, Mapping for safety applications.
VANET-enabled Active Safety Applications: Infrastructure-to-vehicle applications, Vehicle-to-vehicle applications, Pedestrian-to-vehicle applications.

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

CO1	:	Illustrate fundamentals of wireless vehicular networks.
CO2	:	Design of Physical & MAC layer and routing protocols for vehicular networks.
CO3	:	Analyse the security issues and energy management in vehicular networks.
CO4	:	Evaluate the performance of vehicular networks in different use cases.

References

1. Hannes Hartenstein and Kenneth Laberteaux (eds.), VANET Vehicular Applications and Inter-networking Technologies, John Wiley & Sons, 2009. ISBN 9780470740569 Edition 1
2. Christophe Sommer and Falko Dressler, Vehicular Networking, Cambridge University Press, 2014. ISBN 9781107046719
3. Claudia Campolo, AntonellaMolinaro and Riccardo Scopigno, Vehicular ad hoc Networks: Standards, Solutions, and Research, Springer, 2015. ISBN 9783319154961
4. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005. Edition 2
5. Hannes Hartenstein and Kenneth Laberteaux (eds.), VANET Vehicular Applications and Inter-networking Technologies, John Wiley & Sons, 2009. ISBN 9780470740620

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MIM325DK	**Essentials of Project Management**	CIE Marks	:	100
Credits L-T-P	:	3-0-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL	*(Interdisciplinary Elective)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
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	**9 Hours**
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	**9 Hours**
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	**9 Hours**
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	**9 Hours**
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, hemes / 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).

References

1. Prasanna Chandra, Project Planning Analysis Selection Financing Implementation & Review, Tata McGraw Hill Publication, 9th Edition, 2017, ISBN: 978-9332902572.
2. Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK Guide), 5th Edition, 2013, ISBN: 978-1-935589-67-9
3. Harold Kerzner, Project Management A System approach to Planning Scheduling & Controlling, John Wiley & Sons Inc., 11th Edition, 2013, ISBN 978-1-118-02227-6.
4. Rory Burke, Project Management – Planning and Controlling Techniques, John Wiley & Sons, 4th Edition, 2004, ISBN: 978-0470851241

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MIS325DM	**User Interface and User Experience**	CIE Marks	:	100
Credits L-T-P	:	3-0-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL	*(Interdisciplinary Cluster Course-D)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
What's a UI Pattern?: How Users Interact With Design Patterns, Following Universal Design Conventions, Applying Empathy to UI Design Patterns. Why Use UI Patterns?: Why Patterns Work, Expectations Reinforce Themselves, Deadline-Busting Communication, Why not use patterns?. The Importance of Prototyping First: Got a Pattern? Plan it Out, Thinking Through the Process, Patterns Take Guesswork Off of Developers' Plates.	
UNIT - II	**9 Hours**
User Testing: Insights You Can't Ignore. Prototyping UI Patterns: Explaining the Gray Box, Pattern Libraries Are Prototyping Shortcuts, Reusable elements, Patterns and Prototypes Work Together, Applying UI Design Patterns: Building a Pattern Library, Riffing on Design Patterns, Tweaking Pattern Styles, Going forward, Useful UI Pattern Examples, Formatting Data, Getting input, Navigation, Teasers.	
UNIT - III	**9 Hours**
Design for Usefulness: Painkillers & Vitamins, Embracing Goal-Centered Design, Test for Relevancy With an MVP, A Quick MVP Case Study: Buffer. Designing for Usability: Forgiving, Satisfying, The 6-Step Process to Improve Usability. Designing for Desirability: Desirable Products Are More Usable, Desire Is Relative to Users, Elements of Desirable Design.	
UNIT - IV	**9 Hours**
Designing for Findability: Building the Right Information Architecture, 5 IA Layouts for the Web, 5 Navigational Menu Patterns, Testing Findability. Designing for Accessibility: Universal Design, What Accessibility Means for UX Design, Benefits of Accessibility, Accessibility Best Practices,	
UNIT - V	**9 Hours**
The Core of Desirable Design: The Habit Loop, A Quick Case Study, Quick Case Study: Apple.com. Designing for Credibility: First Impressions Matter, Quick Case Study: Chase, Building a Credible Product Interface, Selling the Product Through Social Proof, Persuading Through Transparency.	

Course Outcomes:

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

CO1	:	Apply the concept of User Interface and User Experience to increase look and feel various applications.
CO2	:	Analyze the usability, accessibility, availability and other factors of User Interface design patterns.
CO3	:	Design and implement techniques of implementing design patterns.
CO4	:	Evaluate the design patterns and elements of user experience.

References

1. Ben Gremillion, Jerry Cao, Kamil, Tactical UI Design Patterns, The Handbook to faster Design, UXPin Inc., 2015.
2. Jerry Cao, Kamil, Matt Ellis, The Elements of Successful UX Design, Best Practices of Meaningful products, UXPin Inc., 2015.
3. User Friendly- How the Hidden Rules of Design Are Changing the Way We Live, Work, and Play, Cliff Kuang, Picador Paper; Reprint edition, 2020, ISBN: 1250758203
4. Jenifer Tidwel, Designing Interfaces: Patterns for Effective Interaction Design, 3rd Edition, O'Reilly, 2020, ISBN: 1492051969

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MMA325DN	**Mathematical Methods for Data Science**	CIE Marks	:	100
Credits L-T-P	:	3-0-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL	*(Interdisciplinary Cluster Course-D)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Parameter Estimation: Introduction to probability models of univariate random variables, Discrete distribution (Bernoulli, Binomial, Poisson), Continuous distributions (Uniform, Exponential, Normal), Estimation - Criteria for good estimates - unbiasedness, consistency, efficiency and sufficiency, Variance of a point estimator, Parameter estimation via maximum likelihood, Method of moments, Bayesian estimation of parameters.	
UNIT - II	**9 Hours**
Optimization I: Introduction and formulation, Optimality conditions, Review of local maxima, and local minima along with first and second order conditions. Taylor series and local function approximation, automatic differentiation, One dimensional Search Methods - Sequential search method, Fibonacci search method, Golden section search method.	
UNIT - III	**9 Hours**
Optimization II: Constrained and Unconstrained optimization, Gradient vector, Hessian matrix, optimization using Hessian matrix, Gradient descent method, Step size selection and convergence, Newton method, Stochastic gradient descent (SGD), Convex optimization, Duality - weak and strong duality, Optimization using duality.	
UNIT - IV	**9 Hours**
Fuzzy Optimization: Basic concepts of fuzzy sets - Operations on fuzzy sets, Fuzzy relation equations, Fuzzy logic control, Fuzzification, Defuzzification, Decision making logic, Membership functions. Artificial Neural Networks: Introduction - Neuron model, Multilayer perceptions - Back propagation algorithm and its variants, Loss functions in artificial neural networks.	
UNIT - V	**9 Hours**
Machine Learning Algorithms: Unsupervised learning, Supervised learning, Linear regression, Multiple Linear Regression, Overfitting, Naïve Bayes classifier. Clustering methods, k-means clustering, Linear support vector machine, Kernel functions and Nonlinear support vector machine.	

Course Outcomes:

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

CO1	:	Explore fundamental concepts of estimation, optimization, and machine learning applied in various branches of engineering.
CO2	:	Apply theoretical concepts of estimation and optimization to model problems using a machine learning approach on model requirements and to evaluate solutions within given constraints effectively.
CO3	:	Analyse and solve the modern engineering problems using appropriate techniques of statistical and mathematical learning to the real-world problems arising in many practical situations.
CO4	:	Develop and implement algorithms for constrained and unconstrained optimization, utilizing estimation techniques to classify, predict, and optimize solutions for practical applications, emphasizing model accuracy and performance and also engage in lifelong learning.

References
1. Jorge Nocedal Stephen J. Wright, Numerical Optimization, Springer, 2nd Edition, 2006, ISBN-10: 0-387-30303-0 ISBN-13: 978-0387-30303-1.
2. Mykel J. Kochenderfer, Tim A. Wheeler, Algorithms for Optimization, MIT Press, Illustrated Edition, 2019, ISBN-13 978-0262039420.
3. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 1st Edition, 2006, ISBN-10: 0-387-31073-8 ISBN-13: 978-0387-31073-2.
4. Shai Shalev-Shwartz and Shai Ben-David "Understanding Machine Learning: From Theory to Algorithms", 1st Edition, Cambridge University Press, 2014, ISBN: 978-1-107-05713-5.
5. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications**,** 1st Edition, Prentice Hall PTR, 1995, ISBN 0-13-101171-5.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **THREE quizzes** will be conducted (Two regular quizzes and one optional improvement quiz) & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **THREE** tests will be conducted (Two regular tests and one optional improvement test). Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MME325DO	**Industry 4.0: The Smart Manufacturing**	CIE Marks	:	100
Credits L-T-P	:	3-0-0		SEE Marks	:	100
Hours	:	45L+45EL	*Elective D (Global Elective)*	SEE Durations	:	3 Hrs

UNIT - I	**9 Hrs**
Fundamentals of Industry 4.0-Introduction, Key Components of Industry 4.0, RAMI 4.0, Cyber-Physical Systems. Servitization and Product-Service Systems - Integrated Overview, Examples Across Sectors. Industry 4.0 Across Sectors- Introduction, Smart Manufacturing, Transportation 4.0, Multimodal Transportation Systems, Rail 4.0, Logistics 4.0 and Implications. Future Trends and Challenges- Emerging Applications, Risks and Barriers to Implementation	
UNIT - II	**9 Hrs**
The Concept of IIoT- Introduction to IIoT, Key Features and Applications Modern Communication Protocols- Overview, TCP/IP, Wireless Communication, Technologies. API- A Technical Perspective, Importance in IIoT, Examples and Applications,Middleware Architecture- Role in IIoT, Integration and Data Flow Management. Emerging Trends in IIoT- Industrial IoT Standards and Frameworks, Edge Computing in IIoT.	
UNIT - III	**9 Hrs**
Data Analytics in Manufacturing: Energy Efficiency in Manufacturing, Anomaly Detection in Air Conditioning Systems, Smart Remote Machinery Maintenance Systems with Komatsu, Quality Prediction in Steel Manufacturing, Predictive Maintenance with Data Analytics Internet of Things and New Value Proposition: IoT in Manufacturing, Value Creation Barriers: Standards, security, and privacy concerns. Advances in Robotics in the Era of Industry 4.0: Recent Technological Components of Robots, Advanced Sensor Technologies, Artificial Intelligence in Robotics, Collaborative Robots, Internet of Robotic Things, Cloud Robotics, Digital Twin Technology	
UNIT - IV	**9 Hrs**
Additive Manufacturing Technologies and Applications: Additive Manufacturing Technologies Overview, Stereo lithography, 3D Printing, Fused Deposition Modeling, Selective Laser Sintering, Laser Engineered Net Shaping, Manufacturing in Industry 4.0, Hybrid Manufacturing Processes. Advances in Virtual Factory Research and Applications: The State of Art, The Virtual Factory Software	
UNIT - V	**9 Hrs**
Cybersecurity and Resilience in Industry 4.0: Introduction to Cybersecurity in Industry 4.0, Industrial IoT security, Edge and Cloud Security, Digital Twin Security, AI and Machine Learning for Cybersecurity, Standards and Frameworks for Industry 4.0 Cybersecurity, Resilience Strategies for Industry 4.0, Future Trends in Cybersecurity for Industry 4.0	

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

References:

1. Alasdair Gilchrist, Industry 4.0 The Industrial Internet Of Things, Apress Publisher, ISBN-13 (pbk): 978-1-4842-2046-7 Year 2016, Edition 1
2. Alp Ustundag, Emre Cevikcan, Industry 4.0: Managing The Digital Transformation, Springer, 2018 ISBN 978-3-319-57869-9. Edition 1
3. Ovidiu Vermesan and Peer Friess, Designing the industry - Internet of things connecting the physical, digital and virtual worlds, Rivers Publishers, 2016 ISBN 978-87-93379-81-7
4. Christoph Jan Bartodziej, The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, Springer Gabler, 2017 ISBN 978-3-6581-6502-4.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MME325DQ	**Industrial Internet of Things (IIoT)**	CIE Marks	:	100
Credits L-T-P	:	3-0-0	(Theory)	SEE Marks	:	100
Hours	:	45L+45EL	*(Interdisciplinary Cluster Course-D)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Introduction: IoT vs IIoT, challenges in deployment, building blocks of business model and architecture, layers, sensing for manufacturing process, processing, communication and networking. Applications – Factories and assembly lines, inventory management and quality control, facility management. Industrial Control Systems: Process Industries versus Discrete Manufacturing Industries – Levels, variables and parameters, Continuous Control Systems, Discrete Control Systems, Computer Process Control - Control Requirements, Capabilities of Computer Control, Forms of Computer Process Control.	
UNIT - II	**9 Hours**
Sensors in IIoT applications: Temperature sensor interfacing, accelerometer sensor interfacing, MoS Gas sensor, magneto strictive sensors, speed sensor, ultrasonic sensor, smart sensors. Automatic identification and data Capture: Overview Of Automatic Identification Methods, Linear (One-Dimensional) Bar Code, Two-Dimensional Bar Codes, Radio Frequency Identification, Magnetic Stripes, Optical Character Recognition, Machine Vision	
UNIT - III	**9 Hours**
Group Technology and Cellular Manufacturing: Part Family, Intuitive Grouping, Parts Classification and Coding, Production Flow Analysis, cellular manufacturing - Composite Part Concept, Machine Cell Design, applications of group technology, Opitz Part Coding System, Machine Cell Organization and Design Rank-Order Clustering - Numerical	
UNIT - IV	**9 Hours**
Industrial Networking: Introduction, Hierarchy of Industrial Networks, Network Topologies, Data Flow Management, Transmission Hardware, Network Backbones, Network Communication Standards, Fieldbus Networks Simulating Industrial Processes: Queues and Queueing – waiting time, service time, machine utilisation, Modelling an Industrial Process Designing a Process Simulation, managing resource utilisation, product mixes, Queuing network models.	
UNIT - V	**9 Hours**
Clustering: Similarity measures, hierarchical clustering – single linkage, complete linkage, average linkage Non-hierarchical clustering – Numerical, multidimensional scaling correspondence analysis - Numerical Prediction Models: K- Nearest neighbour, RMS Error and Mean Absolute Error, Mean Absolute Percentage Error, Coefficient of Determination, Underfitting and Overfitting, Cross-Validation, multiple regression – Numerical.	

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

CO1	:	Analyze the differences between IoT and IIoT, and evaluate the challenges, architectures, and sensing layers involved in the deployment of IIoT for manufacturing and industrial applications.
CO2	:	Demonstrate the ability to interface sensors in IIoT systems, and apply automatic identification techniques for process automation.
CO3	:	Design machine cells using group technology principles, and implement cellular manufacturing systems for optimized production workflows.
CO4	:	Develop simulation models for industrial processes, and predict outcomes to optimize industrial system performance.

References
1. Jeschke, S., Brecher, C., Song, H., & Rawat, D. B. (Eds.). (2017). Industrial Internet of Things: Cyber manufacturing Systems. Springer. ISBN: 978-3-319-42559-7.
2. Groover, M. P. (2018). Automation, Production Systems, and Computer-Integrated Manufacturing (5th edition.). Pearson. ISBN: 978-0134605463.
3. Johnson, R. A., & Wichern, D. W. (2007). Applied Multivariate Statistical Analysis (6th edition). Pearson Prentice Hall. ISBN: 978-0131877153.
4. Hill, R., & Berry, S. (2021). Guide to Industrial Analytics: Solving Data Science Problems for Manufacturing and the Internet of Things. Springer. ISBN: 978-3-030-79103-2

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl.No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: II						
Course Code	:	MIM426RT	**Research Methodology**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Online Course)*	SEE Marks	:	50
Hours	:	16L	*(Common Course to all M.Tech Programs)*	SEE Duration	:	2 Hours

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1: A group discussion on what is research; Overview of research
Week 2: Literature survey, Experimental skills
Week 3: Data analysis, Modelling skills
Week 4: Technical writing; Technical Presentations; Creativity in Research
Week 5: Creativity in Research; Group discussion on Ethics in Research
Week 6: Design of Experiments
Week 7: Intellectual Property
Week 8: Department specific research discussions

References

1. Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Integration of Principles, Methods and Techniques, 17th Impression, Pearson India Education Services Pvt. Ltd, 2018. ISBN: 978-81-7758-563-6
2. William M. K. Trochim, James P. Donnelly, The Research Methods Knowledge Base, 3rd Edition, Atomic Dog Publishing, 2006, ISBN: 978-1592602919
3. Kothari C.R., Research Methodology Methods and Techniques, 4th Edition, New Age International Publishers, 2019, ISBN: 978-93-86649-22-5.
4. Levin, R.I. and Rubin, D.S., Statistics for Management, 8th Edition, Pearson Education: New Delhi, 2017, ISBN-13- 978-8184957495.

GENERAL GUIDELINES

1. NPTEL is an acronym for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science.
2. NPTEL is offering online certification courses through its portal - https://swayam.gov.in/nc_details/NPTEL
3. Enrollment to courses and exam registration can be done in ONLINE mode only. The link is available on NPTEL website http://nptel.ac.in/
4. Students need to enroll for the NPTEL course and clear the exam.
5. In case students fail to get the certificate, they need to enroll for the same course once again, in the subsequent NPTEL semester and clear the exam.
6. If the same course is not offered by NPTEL (i.e. if the same course is not re-run) in the subsequent semester by NPTEL, the students need to write letter seeking permission from the Counsellor, HoD and Dean Academics with further approval from BoS Committee to take alternative course from the list announced by NPTEL.
7. Exam is conducted by NPTEL.

SEMESTER: II						
Course Code	:	MHT427DL	**Design Thinking Laboratory**	CIE Marks	:	50
Credits L-T-P	:	0-0-2	*(Design Thinking)*	SEE Marks	:	50
Hours/Week	:	4	*(Practice)*	SEE Duration	:	2 Hours

Contents

Design thinking is a methodology which provides a solution-based approach to solving problems. It is extremely useful when used to tackle complex problems, as it serves to understand the societal needs involved, reframe the problem in human-centric ways, create numerous ideas in brainstorming sessions and adopt a hands-on approach to prototype and testing.

The 5 Stages in the Design Thinking Process

Stage 1: Empathize—Compile Users' Needs.
Stage 2: Define—State Users' Needs and Problems.
Stage 3: Ideate—Challenge Assumptions and Create Ideas.
Stage 4: Prototype—Start to Create Solutions.
Stage 5: Test—validate the solutions obtained.

The five stages of design thinking will help students to apply the methodology to solve complex problems that occur in product designs. The students are encouraged to apply the 5 stages in the Design Thinking Process to solve the problems in the area identified.

The broad areas identified for the M.Tech in Highway Technology is as under:

1. Design of bituminous pavements using field data viz., Characterization of pavement materials, design as per MEPDG considering sustainability and life cycle cost
2. Design of Composite pavement using field data
3. Design of Concrete / White topping for given field data
4. Traffic signal design and coordination; signal delay and benefit cost analysis of alternate designs
5. Activity based transportation planning with field data
6. Design of alternate alignments for bypass around a congested town
7. Alternate / Optimal M&R actions for typical Toll-Operate – Transfer project
8. Alternate alignment for Urban Flyovers – Planning and Design
9. Design of Green highways
10. Road Safety Audit at design stage /during maintenance

Course Outcomes: After going through this course the student will be able to:		
CO1	:	Demonstrate a clear understanding of the principles and stages of the design thinking process, including empathy, ideation, prototyping, and testing.
CO2	:	Apply design thinking methodologies to address complex real-world challenges and drive innovation.
CO3	:	Analyse and evaluate the success of design solutions and identify areas for improvement.
CO4	:	Develop creativity, problem-solving skills and learn iterations, trial and error, and failure that are all part of the creative learning process.
Reference Books		
1. https://onlinecourses.nptel.ac.in/noc22_mg32/preview		

RUBRIC FOR CONTINUOUS INTERNAL EVALUATION (CIE-Lab)

The evaluation of the work will be carried out by the committee appointed by the Head of the department. Student/team should submit a report on the Case Studies solved under the theme.
Evaluation will be carried out in THREE Phases.

Phase	Activity	MARKS
I	Phase I	10
II	Phase II	15
III	Phase III and Draft report	15
	Final report	10
	MAXIMUM MARKS FOR THE CIE	**50**

RUBRIC FOR SEMESTER END EXAMINATION (SEE-Lab)

The evaluation will be done by Internal and External examiners through Exhibition Mode.
The following weightage would be given for the exhibition:

Q.NO.	CONTENTS	MARKS
1	Presentation through posters	15
2	Demonstration of the Prototype	25
3	Viva-Voce	10
	MAXIMUM MARKS FOR THE SEE	**50**

SEMESTER: III						
Course Code	:	MHT331TA	**Highway Construction and Maintenance**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Professional Core Course)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Plants and Equipment: Components of pavement structure, functions and requirements, Plants and Equipment: Excavators, graders, compactors, crushers, bituminous hot mix plants, cement concrete mixers, pavers - uses in road construction, EV operation for equipment- carbon credit/ foot print	
UNIT - II	**9 Hours**
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, Application of geo-synthetics for drainage, RE Panel walls design and construction	
UNIT - III	**9 Hours**
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, WMM, CRM, stabilized pavement layers, Geo synthetics in pavement construction, quality control tests Construction of Bituminous Layers: Different types of bituminous layers, specifications and construction of bituminous layers, quality control tests	
UNIT - IV	**9 Hours**
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 - V	**9 Hours**
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, alternate rehabilitation and recycling. Digital monitoring of construction	

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	:	Apply the specifications and steps for construction of pavement layers
CO3	:	Select appropriate plants and equipment for construction considering optimal output.
CO4	:	Design highway drainage system and apply construction aspects of pavement maintenance.

References
1. MoRTH 'Specifications for Road and Bridge works' 2013, fifth revision, Indian roads Congress, New Delhi
2. Construction Planning, Equipment, and Methods: Robert L.Peurifoy, Clifford J. Schexnayder, Aviad Shapira,Robert Schmitt, 2013 McGraw-Hill, ISBN-13: 978-0073401126
3. Prithvi Kandhal, Veeraragavan, A and Rajan Choudhary, Bituminous Road Construction in India, Second Edition, PHI Learning, 2024
4. Sivakumar Babu, G.L, Prithivi S. Kandhal, Nivedya Mandankara Kottayi, Rajib Basu Mallick and Amirthalingam Veeraragavan, ' Pavement Drainage – Theory and Practice, CRC Press, 2020
5. E. Ray Brown; Prithvi S. Kandhal; Freddy L. Roberts; Y. Richard Kim; Dah-Yinn Lee 'Hot Mix Asphalt Materials, Mixture Design and Construction', 3rd Edition, National Asphalt Pavement Association, Maryland, USA , ISBN: 978-0-692-78646-8
6. Indian Road Congress Publications, New Delhi IRC :14,IRC :15, IRC :35, IRC:67, IRC:109, IRC:111, IRC:113,IRC:120,IRC: IRC:SP:42, IRC:SP:50-, IRC SP: 059 : IRC:SP:68, IRC:SP:76-, IRC:SP-95, IRC SP 102

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
CIE will consist of TWO Quizzes (Q), TWO Tests (T), and ONE Experiential Learning (EL) component **[20 (Q) + 40 (T) + 40 (EL) = 100 marks)**		
Sl. No.	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & each Quiz will be evaluated for 10 marks, and Final Quiz marks adding up to 20 marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE	**100**
RUBRIC FOR SEMESTER END EXAMINATION (SEE-Theory)		
Q.NO.	**CONTENTS**	**MARKS**
1 & 2	Unit 1: Question 1 or 2	20
3 & 4	Unit 2: Question 3 or 4	20
5 & 6	Unit 3: Question 5 or 6	20
7 & 8	Unit 4: Question 7 or 8	20
9 & 10	Unit 5: Question 9 or 10	20
	MAXIMUM MARKS FOR THE SEE	**100**

SEMESTER: III						
Course Code	:	MST332E1	**Interior Design**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16L	*Professional Cluster Elective - Group E (NPTEL-Online)*	SEE Duration	:	2 Hours

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1: Module 1: Interior Design: Definition; Understanding; History of Interior Design; Scope
Module 2: Interior Design; Interior Decoration; and Interior Architecture
Module 3: Interior Design Projects: Overview on Costing and Career
Module 4: Interior Design: Case Studies and Examples
Module 5: Summary and Discourse

Week 2: Module 1: Principles and Elements of Interior Design: Discussion and Examples; Understanding Composition
Module 2: Space Making Elements - wall, column, partition screen, floor, furniture, interior landscaping
Module 3: Trends, Concepts and Schemes in Lighting, Colour, Furnishing, Finishes
Module 4: Interior Design: Drawings and Representation Techniques
Module 5: Summary and Discourse

Week 3: Module 1:Interior Design: Understanding varied spaces – Retail; Work; Living; Restorative; Public; Transient, Concepts of Place and Space
Module 2: Interior-Design – Finishes, Materials and Specifications: diverse surface treatments, finishes, materials, specifications and application techniques
Module 3: Interior-Design – Finishes, Materials and Specifications: Space-Making Crafts; Space-Surface Crafts - traditional, folk and contemporary crafts and their role in creating and enhancing interior spaces
Module 4: skills; building (space-making) crafts; building (space-making) elements; tools; techniques; technology; local resources; community participation; establishing inter-relationships
Module 5: Summary and Discourse

Week 4: Module 1:Interior Design: Materials - Timber
Module 2: Interior Design: Materials - Stone
Module 3: Interior Design: Materials - Tiles
Module 4: Interior Design: Materials - Paints
Module 5: Summary and Discourse

Week 5: Module 1: Green Interiors: Introduction to Rating Systems; Examples
Module 2: Green Interiors: Attributes – IAQ, IEQ, Furniture
Module 3: Green Interiors: Physics of Light - Day Light, Artificial Light, Chemistry of Colours
Module 4: Green Interiors: Policies and Incentives; Materials and Finishes
Module 5: Summary and Discourse

Week 6: Module 1: Interior Design Technology: Innovative trends and technologies – Tiny Houses, Origami
Module 2: Interior Design Technology: Experimental finishes and materials; Joinery
Module 3: Interior Design Technology: Visual Merchandising; Concepts of Modularity, Portability, Foldability, DIY
Module 4: Interior Design Technology: New Concepts – Installations, Decor
Module 5: Summary and Discourse

Week 7: Module 1: Professional Practice: Interior services, functional importance
Module 2: Professional Practice: bylaws, supervision
Module 3: Building Material Costing; BoQ; Market Exposure; Product Catalogues

Module 4: Important Organizations, Institutes, Firms, Designers, Avenues of Pedagogy and Practice
Module 5: Summary and Discourse
Week 8: Module 1: Trans-Disciplinary Interventions: Craft-Design Explorations
Module 2: Trans-Disciplinary Interventions: Craft-Design Explorations
Module 3:Creative and Cultural Industries: Focus on Visual Art and Interior Design
Module 4:Interior Design: Future Roadmap; Opportunities and Challenges
Module 5:Summary and Discourse

References

1. Brooker, Graeme. "Form + Structure: the organization of interior space", AVA Publishing SA,Switzerland,
2. Coles, J and House, N. "The Fundamentals of Interior-Architecture", Ava Publishing, 2007
3. Chauhan, Muktirajsinhji (et.al.). "A History of Interior Design in India, Vol.1: Ahmedabad", SID, CEPT,University, 2007
4. Dernie, D. "Architecture, Imagination and Material Culture", Wiley-Academy, 2000

GENERAL GUIDELINES

1. NPTEL is an acronym for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science.
2. NPTEL is offering online certification courses through its portal - https://swayam.gov.in/nc_details/NPTEL
3. Enrollment to courses and exam registration can be done in ONLINE mode only. The link is available on NPTEL website http://nptel.ac.in/
4. Students need to enroll for the NPTEL course and clear the exam.
5. In case students fail to get the certificate, they need to enroll for the same course once again, in the subsequent NPTEL semester and clear the exam.
6. If the same course is not offered by NPTEL (i.e. if the same course is not re-run) in the subsequent semester by NPTEL, the students need to write letter seeking permission from the Counsellor, HoD and Dean Academics with further approval from BoS Committee to take alternative course from the list announced by NPTEL.
7. Exam is conducted by NPTEL

SEMESTER: III						
Course Code	:	MST332E2	**Development and Applications of Special Concretes**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16L	*Professional Cluster Elective - Group E (NPTEL-Online)*	SEE Duration	:	2 Hours

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1: Normal concrete
Week 2: Normal concrete (continued)
Week 3: Special concretes (1) – Concreting in cold and hot weather
Week 4: Special concretes (2) – Self-compacting and fiber reinforced concretes
Week 5: Special concretes (3) – Basic understanding of high strength concrete, mass concrete and shotcrete
Week 6: Special concretes (4) – Handling preplaced aggregate concrete and light weight aggregate concrete
Week 7: Special concretes (5) – Special topics I: Underwater anti-washout concrete; micro-concrete
Week 8: Special concretes (6) – Special topics II: Expansive concrete, roller compacted concrete, concrete using recycled aggregate

References:

1. Mehta, P.K., and Monteiro P.J.M., Concrete – Microstructure, Properties and Materials, 3rd Edition, McGraw Hill Education (India) Private Limited, New Delhi, Prentice-Hall, Inc., 2006.
2. Neville, A.M., Properties of concrete, 5th Edition, Pitman Publishers, New Delhi, India 1996.
3. Shetty, M.S., Concrete Technology (Theory and Practice), 7th Edition, S. Chand & Company Ltd., New Delhi, 2013.
4. Sidney, M., Young, J.F., and Darwin, D., Concrete, 2nd Edition, Prentice-Hall, Pearson Education, Inc., New Jersey, 2003.

GENERAL GUIDELINES

1. NPTEL is an acronym for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science.
2. NPTEL is offering online certification courses through its portal - https://swayam.gov.in/nc_details/NPTEL
3. Enrollment to courses and exam registration can be done in ONLINE mode only. The link is available on NPTEL website http://nptel.ac.in/
4. Students need to enroll for the NPTEL course and clear the exam.
5. In case students fail to get the certificate, they need to enroll for the same course once again, in the subsequent NPTEL semester and clear the exam.
6. If the same course is not offered by NPTEL (i.e. if the same course is not re-run) in the subsequent semester by NPTEL, the students need to write letter seeking permission from the Counsellor, HoD and Dean Academics with further approval from BoS Committee to take alternative course from the list announced by NPTEL.
7. Exam is conducted by NPTEL

SEMESTER: III						
Course Code	:	MST332E3	**Earthquake Resistant Design of Foundations**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16L	*Professional Cluster Elective - Group E (NPTEL-Online)*	SEE Duration	:	2 Hours

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1: Introduction: General requirements, types of shallow and deep foundations and their use; performance of various types of foundations during past earthquakes. Shallow Foundations: IS codes for bearing capacity and settlement of foundations, foundation design, modes of soil failure.

Week 2: Shallow Foundations: Safe bearing capacity, differential & total settlements, increase in permissible stress under earthquake loads. Methods of analysis, experimental investigations, Combined footings for earthquake loads

Week 3: Shallow Foundations: Raft foundation, modulus of sub grade reaction, Winkler model, beam on elastic foundation. Dynamic Bearing Capacity under Transient & Earthquake Type Loads: Types of dynamic loads; Footing requirements to account for settlements and earthquake induced forces; Pseudo-Static analysis of footings with eccentric & inclined loads. Effect of horizontal load and moment. Dynamic Analysis of shallow foundations for various modes of vibrations

Week 4: Pile Foundations: Types of piles based on usage, material, construction etc. pile load capacity in compression, Bearing capacity of piles, group action of piles, settlement of a pile group

Week 5: Pile Foundations: Laterally loaded piles, elastic analysis; Reese and Matlock approach, fixity of pile heads, dimensionless factors; Pile with dynamic loads.

Week 6: Pile Foundations: soil-pile analysis with spring-mass & FEM idealization, elements for slip and separation, soil-pile interaction, IS code of practice for design of pile foundations, piles through liquefiable soils

Week 7: Well Foundations & Caissons: Types; components; scour depth, depth & bearing capacity of wells, static forces considered in stability of wells; Lateral stability of well foundations. Pseudo-static analysis with earthquake induced loads, Lateral load resistance of well foundation; Terzahi's approach; IRC, IS and Indian Railway Codes, their limitations.

Week 8: SSI for Deep Foundations: Soil-Structure Interaction, Modelling of Unbounded Soil Media for Dynamic Loads, Free Field Motion, Kinematic Interaction and Inertial Interaction.

References:

1. Prakash S.(1981),"Soil Dynamics", McGraw-Hill Company,New York.
2. Kramer S.L.(1996),“Geo technical-Earthquake Engineering”, Pearson Education Pvt. Ltd., Singapore.
3. Bowles J.E.(1997),“Foundation Analysis and Design”, McGraw Hill International Editions, Singapore.
4. Ranjan G. and Rao A.S.R.(2004),“Basic and Applied Soil Mechanics”, New Age Int. Ltd., New Delhi.

GENERAL GUIDELINES
1. NPTEL is an acronym for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science. 2. NPTEL is offering online certification courses through its portal - https://swayam.gov.in/nc_details/NPTEL 3. Enrollment to courses and exam registration can be done in ONLINE mode only. The link is available on NPTEL website http://nptel.ac.in/ 4. Students need to enroll for the NPTEL course and clear the exam. 5. In case students fail to get the certificate, they need to enroll for the same course once again, in the subsequent NPTEL semester and clear the exam. 6. If the same course is not offered by NPTEL (i.e. if the same course is not re-run) in the subsequent semester by NPTEL, the students need to write letter seeking permission from the Counsellor, HoD and Dean Academics with further approval from BoS Committee to take alternative course from the list announced by NPTEL. 7. Exam is conducted by NPTEL

SEMESTER: III						
Course Code	:	MHT332E4	**Expansive Soil**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16L	*Professional Cluster Elective - Group E (NPTEL-Online)*	SEE Duration	:	2 Hours

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1: Introduction to soil mechanics
Week 2: Clay mineralogy, introduction to Expansive soils
Week 3: Swelling behavior of expansive soil
Week 4: Swelling-shrinkage characteristics of expansive soil
Week 5: Behaviour of expansive soil
Week 6: Treatment of expansive soil-1
Week 7: Treatment of expansive soil-2
Week 8: Foundation on expansive soil, Engineering application of expansive soil

References:

1. Nelson, J. D. and Miller, D. J. (1992). Expansive soils- problems and practice in foundation and pavement engineering, John Wiley & Sons Inc.
2. Mitchell, J.K. and Soga, J. (2005). Fundamentals of soil behavior, 3rd edition, John Wiley & Sons Inc.
3. Hausmann, M.R. (1990). Engineering Principles of Ground Modification, McGraw-Hill International Editions.

GENERAL GUIDELINES

1. NPTEL is an acronym for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science.
2. NPTEL is offering online certification courses through its portal - https://swayam.gov.in/nc_details/NPTEL
3. Enrollment to courses and exam registration can be done in ONLINE mode only. The link is available on NPTEL website http://nptel.ac.in/
4. Students need to enroll for the NPTEL course and clear the exam.
5. In case students fail to get the certificate, they need to enroll for the same course once again, in the subsequent NPTEL semester and clear the exam.
6. If the same course is not offered by NPTEL (i.e. if the same course is not re-run) in the subsequent semester by NPTEL, the students need to write letter seeking permission from the Counsellor, HoD and Dean Academics with further approval from BoS Committee to take alternative course from the list announced by NPTEL.
7. Exam is conducted by NPTEL

SEMESTER: III						
Course Code	:	MHT332E5	**Construction Methods and Equipment Management**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16L	*Professional Cluster Elective - Group E (NPTEL-Online)*	SEE Duration	:	2 Hours

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1:
Module 1: Introduction to course and Planning Process of Equipment
Lecture 1: Planning process of equipment – Factors affecting equipment selection, Planning equipment utilization, Equipment utilization chart.
Module 2: Cost of Owning and Operating Construction Equipment
Lecture 2: Estimation of Ownership cost (Average Annual Investment method) – Elements of ownership cost, Depreciation accounting methods, Cost Estimation using Average Annual Investment method.
Week 2:
Module 2: Cost of Owning and Operating Construction Equipment
Lecture 3: Estimation of Ownership cost (Time value method) – Use of compounding factors in Equipment cost estimation based on time value method.
Lecture 4: Operating cost of Equipment – Operating cost components, Illustrations on estimation of operating cost.
Lecture 5: Equipment cost estimation
– Caterpillar & Peurifoy method – Illustrations on use of Caterpillar method and Peurifoy method for estimation of total equipment cost.
Week 3:
Module 3: Equipment Life and Replacement Analysis
Lecture 6: Equipment Life and Replacement Analysis (Part 1) – Physical life, Profit life, Economic life, Illustrations on determination of economic life of equipment.
Lecture 7: Equipment Life and Replacement Analysis (Part 2)– Equipment Replacement analysis- Intuitive method, Minimum cost method, Maximum profit method.
Lecture 8: Equipment Life and Replacement Analysis (Part 3) – Determination of economic life based on equivalent annual cost (using time value concept).
Week 4:
Module 4: Engineering Fundamentals of Moving Earth
Lecture 9: Engineering Fundamentals of Moving Earth – Machine Performance-Required power, Available power, Usable power, Rolling resistance, tractive force, co-efficient of traction, Effect of grade on tractive effort, Effect of altitude on performance of IC engines, Performance chart, ways to define payload of equipment.

Module 5: Earthmoving and Excavating equipment
Lecture 10: Bull Dozers – Bull Dozers-Types of dozer blades, blade adjustments, Blade performance, production estimation.
Lecture 11: Scrapers (Part 1) – Scrapers, Scraper operation, types of scraper, Components of production cycle of scraper and pusher.
Lecture 12: Scrapers (Part 2) – Illustrations on production estimation of scraper and balancing interdependent machines.

Week 5: Module 5: Earthmoving and Excavating equipment
Lecture 13: Front End loaders – Front-End loaders –loader attachments, productivity estimation.

Lecture 14: Excavators – Excavators-Front shovels and backhoes, operation, factors affecting selection, production estimation.
Lecture 15: Trucks – Production cycle, cycle time estimation, Productivity of trucks, balancing interdependent machines.

Week 6: Module 6: Piles and Pile driving equipment
Lecture 16: Piles and Pile driving equipment (Part 1) – Pile types: Precast and cast in situ piles, pile hammers, principle of pile hammer, factors affecting pile hammer selection.
Lecture 17: Piles and Pile driving equipment (Part 2) – Types of pile hammer: Drop hammer, Single acting and double acting steam hammers, Diesel hammers, Vibratory pile drivers.

Week 7: Module 7: Lifting equipment
Lecture 18: Cranes (Part 1) – Cranes, Crane motions, Principles of lifting mechanism of crane, types of cranes-lattice boom crawler crane, lattice boom truck mounted cranes, telescopic boom crane.
Lecture 19: Cranes (Part 2) – Types of cranes-Tower cranes, Factors affecting lifting capacity of crane, Range diagram.

Week 8: Module 8: Concreting equipment
Lecture 20: Concreting equipment (Part 1) – Steps in concrete making process, types of concrete mixer machines.
Lecture 21: Concreting equipment (Part 2) & Conclusion – Methods of handling and transporting concrete, Consolidation of concrete, Methods of finishing and curing of concrete.

References:

1. Peurifoy, R., Schexnayder, C., Shapira, A., & Schmitt, R. (2011). “Construction Planning, Equipment, and Methods” (8th ed.). McGraw-Hill.
2. Gransberg, D. D., Popescu, C. M., & Ryan, R. C. (2006). “Construction equipment management for engineers, estimators, and owners” (2nd ed.). CRC Press.
3. Day, D. A., & Benjamin, N. B. H. (1991). “Construction equipment guide” (2nd ed.). John Wiley & Sons.
4. Harris, F. (1994). “Modern construction and ground engineering equipment and methods” (2nd ed.). Pearson Longman.

GENERAL GUIDELINES

1. NPTEL is an acronym for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science.
2. NPTEL is offering online certification courses through its portal - https://swayam.gov.in/nc_details/NPTEL
3. Enrollment to courses and exam registration can be done in ONLINE mode only. The link is available on NPTEL website http://nptel.ac.in/
4. Students need to enroll for the NPTEL course and clear the exam.
5. In case students fail to get the certificate, they need to enroll for the same course once again, in the subsequent NPTEL semester and clear the exam.
6. If the same course is not offered by NPTEL (i.e. if the same course is not re-run) in the subsequent semester by NPTEL, the students need to write letter seeking permission from the Counsellor, HoD and Dean Academics with further approval from BoS Committee to take alternative course from the list announced by NPTEL.
7. Exam is conducted by NPTEL

SEMESTER: III						
Course Code	:	MHT433P	**Minor Project**	CIE Marks	:	50
Credits L-T-P	:	0-0-6		SEE Marks	:	50
Hours/Week	:	12		SEE Duration	:	3 Hours

Guidelines

1. Student can form group of two to execute the Minor Project.
2. Students are required to select topics related to their PG Program Specialization after extensive Literature Survey and analyzing the Research gaps.
3. Students will be assigned to guides in accordance with the expertise of the faculty.
4. Minor project topics could also be aligned to be implemented/executed based on any of the 16 Centre of Excellence (CoE)/ 06 Center of Competence (CoC) domain. The details of these could be obtained by visiting the website https://rvce.edu.in/rvce-center-excellence
5. Minor project has to be implemented/executed in-house, using the resources available in the department/college/CoE/CoC.
6. Students have to note the periodic progress in the Minor Project Diary and report the work carried to their respective guides.
7. Students have to present the Minor project work 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 Minor project report.
8. 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 softbound in Ivory/White 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	:	Analyze the research gaps, formulate the problem definition, conceptualize the objectives and design solution to cater to specific problems.
CO2	:	Apply higher order thinking skills and develop skill competencies specific to program specialization to implement real world problems with professional ethical standards.
CO3	:	Demonstrate the skill and knowledge by applying appropriate tools and techniques specific to their domain.
CO4	:	Communicate, work in teams and demonstrate the learning through oral presentations and report writing.

Scheme of Continuous Internal Evaluation (CIE):
The evaluation committee shall consist of Guide, Professor, Associate Professor/Assistant Professor. The committee shall assess and evaluate the presentation and the progress reports.

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

Reviews	Activity	Weightage
I	Approval of the selected topic, formulation of Problem Statement and Objectives along with Synopsis submission	10%
II	Demonstrate the skill and knowledge by applying appropriate tools/techniques to design solution specific to the problem.	30%
III	Demonstrates the work carried out through experimental results, analysis and testing. Exhibits writing and communication skills through presentations and report writing.	60%

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.

RUBRICS FOR SEMESTER END EXAMINATION

The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner.

Q.NO.	CONTENTS	MARKS
1	Write Up	**20%**
2	Demonstration of Minor Project Work	**60%**
3	Viva voce	**20%**

SEMESTER: III						
Course Code	:	MHT434N	**Internship**	CIE Marks	:	50
Credits L-T-P	:	0-0-6		SEE Marks	:	50
Hours/Week	:	12		SEE Duration	:	3 Hours

Guidelines

1. Students can opt for undergoing internship at the industry or research organizations like BEL, DRDO, ISRO, NAL, etc.
2. Students must submit letter from the industry/research organizations clearly specifying the candidate's name and the duration of the internship on the company letter head with authorized signature.
3. The duration of the internship shall be for a period of 6 weeks on full time basis after II semester final exams and before the commencement of III semester.
4. RVCE hosts around 16 Centre of Excellence (CoE) in various domains and around 06 Center of Competence (CoC). The details of these could be obtained by visiting the website https://rvce.edu.in/rvce-center-excellence
5. Students can approach the CoE/CoC for registering and working on relevant domain for training/internship at the CoE/CoC.
6. Internship must be related to the field of specialization of the respective PG program in which the student has enrolled.
7. Students undergoing internship training are advised to report their progress and submit periodic progress reports/diary to their respective guides.
8. 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.
9. 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 softbound in Ivory/White 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	:	Explore the workplace, operating procedures of the department/company and its products, and other organizational concepts.
CO2	:	Learn and improve writing and communication skills, research and technology, work in a team, and develop leadership skills.
CO3	:	Apply higher order thinking skills - critical thinking, analysis, synthesis and evaluate complex problems to solve real world problems with professional ethical standards.
CO4	:	Develop and demonstrate skill competencies and knowledge specific to program specialization by applying appropriate tools and techniques.

Scheme of Continuous Internal Evaluation (CIE):
The evaluation committee shall consist of Guide, Professor, Associate Professor/Assistant Professor. The committee shall assess and evaluate the presentation and the progress reports.

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

Reviews	Activity	Weightage
I	Ability to comprehend the functioning/operating procedures of the Organization/Departments. Application of Engineering knowledge, Critical thinking and analysis to solve problems.	40%
II	Demonstrates skill competencies, Resource Management and Sustainability. Exhibits writing and communication skills through presentations and report writing.	60%

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.

RUBRICS FOR SEMESTER END EXAMINATION

The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner.

Q.NO.	CONTENTS	MARKS
1	Write Up	**20%**
2	Demonstration of Internship Work	**60%**
3	Viva-Voce	**20%**

SEMESTER: IV						
Course Code	:	MST341F1	**Introduction to Accounting and Finance for Civil Engineers**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16L	*Professional Cluster Elective - Group F (NPTEL-Online)*	SEE Duration	:	2 Hours

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1: Basic Accounting and concepts in finance; Book keeping: definitions, objectives, elements, journal and ledger.
Week 2: Accounting & Concepts in Finance I: definitions, objectives, characteristics, limitations, basic terms; GAAP (Generally Accepted Accounting Principles)
Week 3: Accounting & Concepts in Finance II: Systems of accounting, cash book, bank book, depreciation; provisions, reserves, accounting equation, journal & ledger entries, trial balance, profit & loss; account, balance sheet, cash flow statement)
Week 4: Analysis of financial statements I: Financial leverage, financial ratios
Week 5: Analysis of financial statements II: Significance and applications
Week 6: Financial planning including capital budgeting I: Definition, financial planning options and objectives, time value of money
Week 7: Financial planning including capital budgeting II: simple and compound interest, rule of 72, methods of capital budgeting - payback period
Week 8: Financial planning including capital budgeting III: Accounting rate of return (ARR), net present value (NPV), internal rate of return (IRR)

References

1. Theusen G.J., Fabrycky W.J., Engineering Economy, 9th Edition, Prentice-Hall, Inc., New Delhi, India, 2001.
2. Crundwell F.K., Finance for Engineers-Evaluation and Funding of Capital Projects, Springer, London, UK, 2008. (ISBN 978-1-84800-032-2).
3. Jha K.N., Construction Project Management- Theory and practice, 2nd Edition, Pearson India Education Services Pvt. Ltd., UP, India 2015.

GENERAL GUIDELINES

1. NPTEL is an acronym for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science.
2. NPTEL is offering online certification courses through its portal - https://swayam.gov.in/nc_details/NPTEL
3. Enrollment to courses and exam registration can be done in ONLINE mode only. The link is available on NPTEL website http://nptel.ac.in/
4. Students need to enroll for the NPTEL course and clear the exam.
5. In case students fail to get the certificate, they need to enroll for the same course once again, in the subsequent NPTEL semester and clear the exam.
6. If the same course is not offered by NPTEL (i.e. if the same course is not re-run) in the subsequent semester by NPTEL, the students need to write letter seeking permission from the Counsellor, HoD and Dean Academics with further approval from BoS Committee to take alternative course from the list announced by NPTEL.
7. Exam is conducted by NPTEL

SEMESTER: IV						
Course Code	:	MST341F2	**Structure, Form and Architecture: The Synergy**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16L	*Professional Cluster Elective - Group F (NPTEL-Online)*	SEE Duration	:	2 Hours

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1: Introduction to Structure, Form, and Architecture; Relationship of Structure to Architectural Buildings; Loads on a Structure; Synthesis of Architectural and Structural Forms

Week 2: Connecting Structure and Architecture; Structural Transformation in Architectural History; Factors affecting Structural Forms; Learning from Animal Architecture

Week 3: Basic Structural Properties; Structural Requirements; Structural Arrangements; Structural Forms and Shapes; Structural Materials

Week 4: Structural Typology; Compressive Structures; Tensile Structures; Load Bearing Structure; Temporary Structure

Week 5: Framed Structures; Arch Structures; Vault Structures; Dome Structures; Grid Structures

Week 6: Shell Structures; Truss and Space Frames; Folded Plate Structures; Membrane Structures; Pneumatic Structures

Week 7: Structure and Architectural Forms in Windy areas, Seismic prone areas and Flood prone areas; Cost Effective Structure and Architecture; Structure and Light in Architecture

Week 8: Evaluation of Highrise Structural System; Highrise Structural Components; Mega Structures and Architecture- Case Studies; Architecture-The Past, Present and Future

References

1. Ching, F. D.K. (1996), Architecture: Form, Space & Order, 2nd ed, New York: Van Nostrand Reinhold
2. Hjelmstad, Keith D. (2005), Fundamentals of Structural Mechanics, 2nd ed., Springer.
3. Hulse, Ray and Cain, Jack. (2016), Structural Mechanics, Macmillan International Higher Education
4. Salvadori, M and Heller,R. A. (1986), Structure in Architecture, 3rd ed., Prentice Hall

GENERAL GUIDELINES

1. NPTEL is an acronym for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science.
2. NPTEL is offering online certification courses through its portal - https://swayam.gov.in/nc_details/NPTEL
3. Enrollment to courses and exam registration can be done in ONLINE mode only. The link is available on NPTEL website http://nptel.ac.in/
4. Students need to enroll for the NPTEL course and clear the exam.
5. In case students fail to get the certificate, they need to enroll for the same course once again, in the subsequent NPTEL semester and clear the exam.
6. If the same course is not offered by NPTEL (i.e. if the same course is not re-run) in the subsequent semester by NPTEL, the students need to write letter seeking permission from the Counsellor, HoD and Dean Academics with further approval from BoS Committee to take alternative course from the list announced by NPTEL.
7. Exam is conducted by NPTEL

SEMESTER: IV						
Course Code	:	MHT341F3	**Plastic Waste Management**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16L	*Professional Cluster Elective - Group F (NPTEL-Online)*	SEE Duration	:	2 Hours

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1: Plastics – What it is? Types, Uses and Global Statistics
Week 2: Plastic Waste – Sources, Production, Global and Indian Context
Week 3: Plastic Waste Management Rules 2016 (India) and Global Rules and Regulations
Week 4: Plastic Bans including China Sword Policy implication on global plastic waste management
Week 5: Impact of Plastics on Marine Life, Effect on Wildlife, Human Health and Environment
Week 6: Plastic Waste Management Practices – Use of Plastic waste in roads, issues and challenges
Week 7: Possible Alternate Materials to Plastics –Greener Alternatives
Week 8: Plastics Resource Recovery and Circular Economy.

References

Journal articles, Technical Reports will be collated from the web and made available to course participants

GENERAL GUIDELINES

1. NPTEL is an acronym for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science.
2. NPTEL is offering online certification courses through its portal - https://swayam.gov.in/nc_details/NPTEL
3. Enrollment to courses and exam registration can be done in ONLINE mode only. The link is available on NPTEL website http://nptel.ac.in/
4. Students need to enroll for the NPTEL course and clear the exam.
5. In case students fail to get the certificate, they need to enroll for the same course once again, in the subsequent NPTEL semester and clear the exam.
6. If the same course is not offered by NPTEL (i.e. if the same course is not re-run) in the subsequent semester by NPTEL, the students need to write letter seeking permission from the Counsellor, HoD and Dean Academics with further approval from BoS Committee to take alternative course from the list announced by NPTEL.
7. Exam is conducted by NPTEL

SEMESTER: IV						
Course Code	:	MHT341F4	**Sustainable Engineering Concepts and Life Cycle Analysis**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16L	*Professional Cluster Elective - Group F (NPTEL-Online)*	SEE Duration	:	2 Hours

This course is indicative only and it is subject to change based on the courses running at that time by NPTEL

Duration of the ONLINE Course - 8 Weeks

Week 1: An Introduction to Sustainability Concepts and Life Cycle Analysis (Introduction, Material flow and waste management, What it all means for an engineer? Water energy and food nexus)

Week 2: Risk and Life Cycle Framework for Sustainability (Introduction, Risk, Environmental Risk Assessment, Example Chemicals and Health Effects, Character of Environmental Problems)

Week 3: Environmental Data Collection and LCA Methodology (Environmental Data Collection Issues, Statistical Analysis of Environmental Data, Common Analytical Instruments, Overview of LCA Methodology - Goal Definition, Life Cycle Inventory, Life Cycle Impact Assessment, Life Cycle Interpretation, LCA Software tools)

Week 4: Life Cycle Assessment – Detailed Methodology and ISO Framework (Detailed Example on LCA Comparisons, LCA Benefits and Drawbacks, Historical Development and LCA Steps from ISO Framework)

Week 5: Life Cycle Inventory and Impact Assessments (Unit Processes and System Boundary Data Quality, Procedure for Life Cycle Impact Assessment, LCIA in Practice with Examples, Interpretation of LCIA Results)

Week 6: Factors for Good LCA Study (ISO Terminologies, LCA Steps Recap, Chemical Release and Fate and Transport, and Green Sustainable Materials)

Week 7: Design for Sustainability (Environmental Design for Sustainability: Economic, Environmental Indicators, Social Performance Indicators, Sustainable Engineering Design Principles and Environmental Cost Analysis)

Week 8: Case Studies (e.g., Odour Removal for Organics Treatment Plant, Comparison of Hand Drying Methods, Biofuels for Transportation, Kerosene Lamp vs. Solar Lamp, Bioplastic etc.).

GENERAL GUIDELINES

1. NPTEL is an acronym for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and Indian Institute of Science (IISc) for creating course contents in engineering and science.
2. NPTEL is offering online certification courses through its portal - https://swayam.gov.in/nc_details/NPTEL
3. Enrollment to courses and exam registration can be done in ONLINE mode only. The link is available on NPTEL website http://nptel.ac.in/
4. Students need to enroll for the NPTEL course and clear the exam.
5. In case students fail to get the certificate, they need to enroll for the same course once again, in the subsequent NPTEL semester and clear the exam.
6. If the same course is not offered by NPTEL (i.e. if the same course is not re-run) in the subsequent semester by NPTEL, the students need to write letter seeking permission from the Counsellor, HoD and Dean Academics with further approval from BoS Committee to take alternative course from the list announced by NPTEL.
7. Exam is conducted by NPTEL

SEMESTER: IV						
Course Code	:	MHT442P	**Major Project**	CIE Marks	:	100
Credits L-T-P	:	0-0-18		SEE Marks	:	100
Hours/Week	:	36		SEE Duration	:	3 Hours

Guidelines

1. Major Project is to be carried out for a duration of 18 weeks
2. Student have to implement the Major Project individually.
3. Students are required to select topics related to their PG Program Specialization after extensive Literature Survey and analyzing the Research gaps.
4. Students will be assigned to guides in accordance with the expertise of the faculty.
5. Major project topics could also be chosen to be implemented/executed based on any of the 16 Centre of Excellence (CoE)/ 06 Center of Competence (CoC) domain. The details of these could be obtained by visiting the website https://rvce.edu.in/rvce-center-excellence
6. Major Project could be implemented in Industry/Research organizations after providing the letter of approval. Students can also implement Major Project, in-house using the resources available in the department/college/CoE/CoC.
7. Students have to adhere to the Project Presentation Schedule note the periodic progress in the Major Project Diary and report the work carried to their respective guides.
8. It is mandatory for the students to present/publish their project work in National/International Conferences/Journals
9. Students have to present the Major Project work 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 Major Project report.
10. Major Project report has to 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 softbound in Ivory/White 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	:	Analyze the research gaps, formulate the problem definition, conceptualize the objectives and design solution to cater to specific problems.
CO2	:	Apply higher order thinking skills and develop skill competencies specific to program specialization to implement real world problems with professional ethical standards.
CO3	:	Demonstrate the skill and knowledge by applying appropriate tools and techniques specific to their domain.
CO4	:	Communicate, work in teams and demonstrate the learning through oral presentations and report writing.

Scheme of Continuous Internal Evaluation (CIE):
The evaluation committee shall consist of Guide, Professor, Associate Professor/Assistant Professor. The committee shall assess and evaluate the presentation and the progress reports.

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

Reviews	Activity	Weightage
I	Approval of the selected topic, formulation of Problem Statement and Objectives along with Synopsis submission	10%
II	Demonstrate the skill and knowledge by applying appropriate tools/techniques to design solution specific to the problem.	30%
III	Demonstrates the work carried out through experimental results, analysis and testing. Exhibits writing and communication skills through presentations, report writing and paper publication.	60%

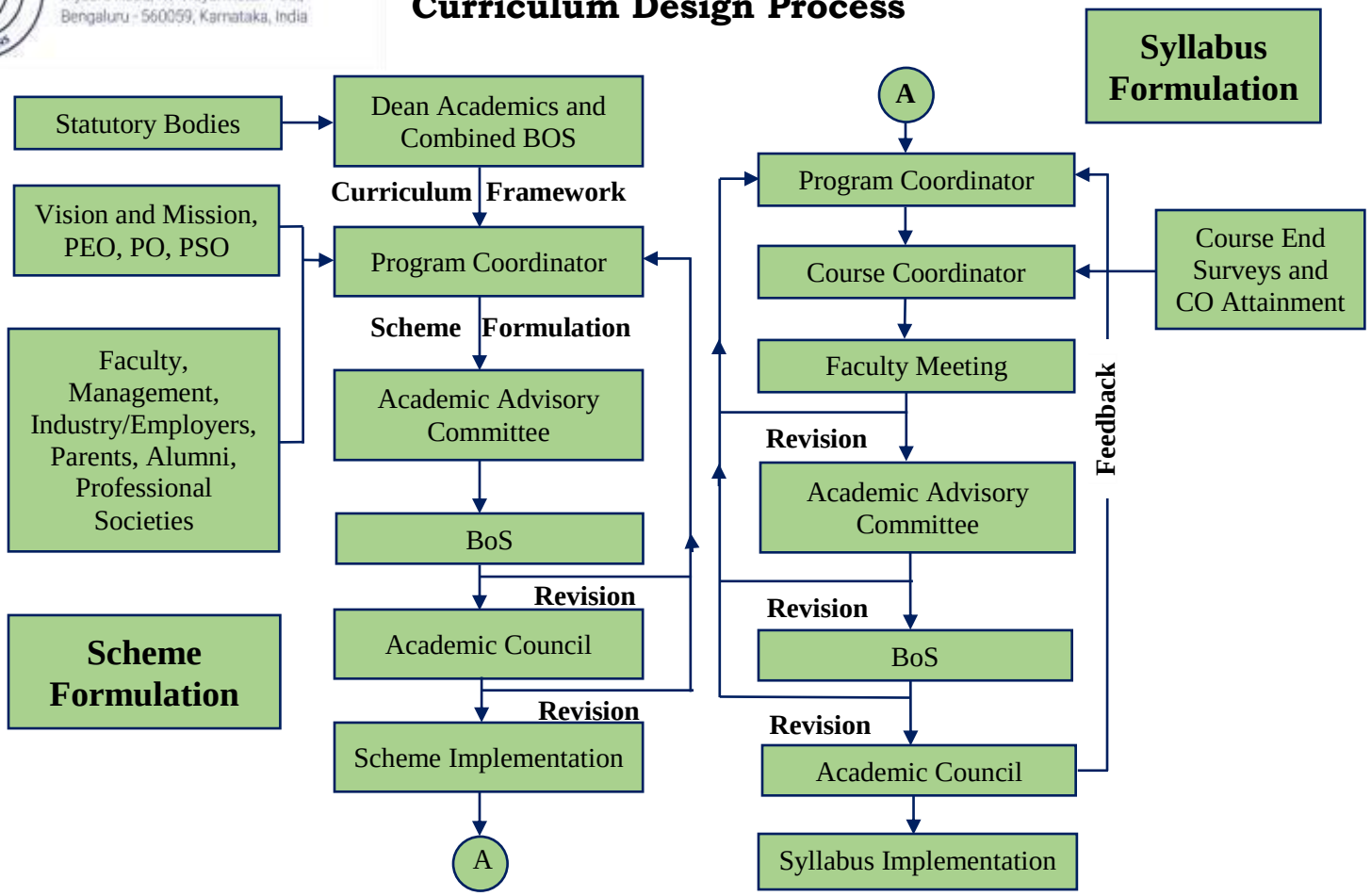
Scheme for Semester End Evaluation (SEE):
Major Project SEE evaluation shall be conducted in two stages. This is initiated after fulfilment of submission of Project Report and CIE marks.
Stage-1 Report Evaluation: Evaluation of Project Report shall be done by the Guide and an External examiner.
Stage-2 Project Viva-voce: Major Project Viva-voce examination is conducted after receipt of evaluation reports from Guide and External examiner.

RUBRICS FOR SEMESTER END EXAMINATION

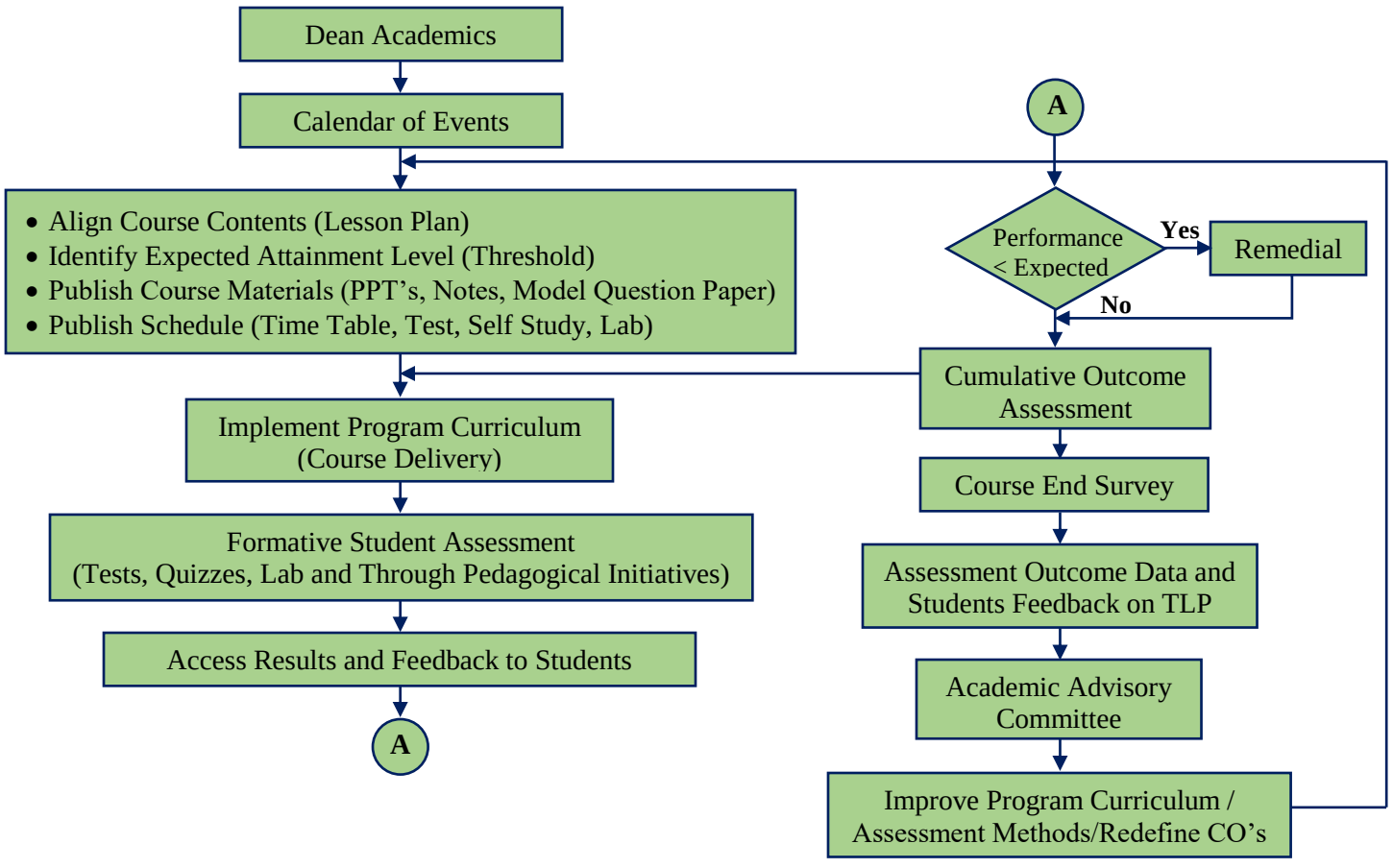
SEE procedure is as follows:

Report Evaluation	Internal Examiner: 100 Marks **(A)**	**Report Evaluation**
	External Examiner: 100 Marks **(B)**	**(A) + (B) = 200/2 = 100 (C)**
Viva-Voce	Jointly evaluated by Internal Guide & External Examiner	**100 (D)**
Total Marks = **(C+D)/2** = 200/2 =100		**100 Marks**

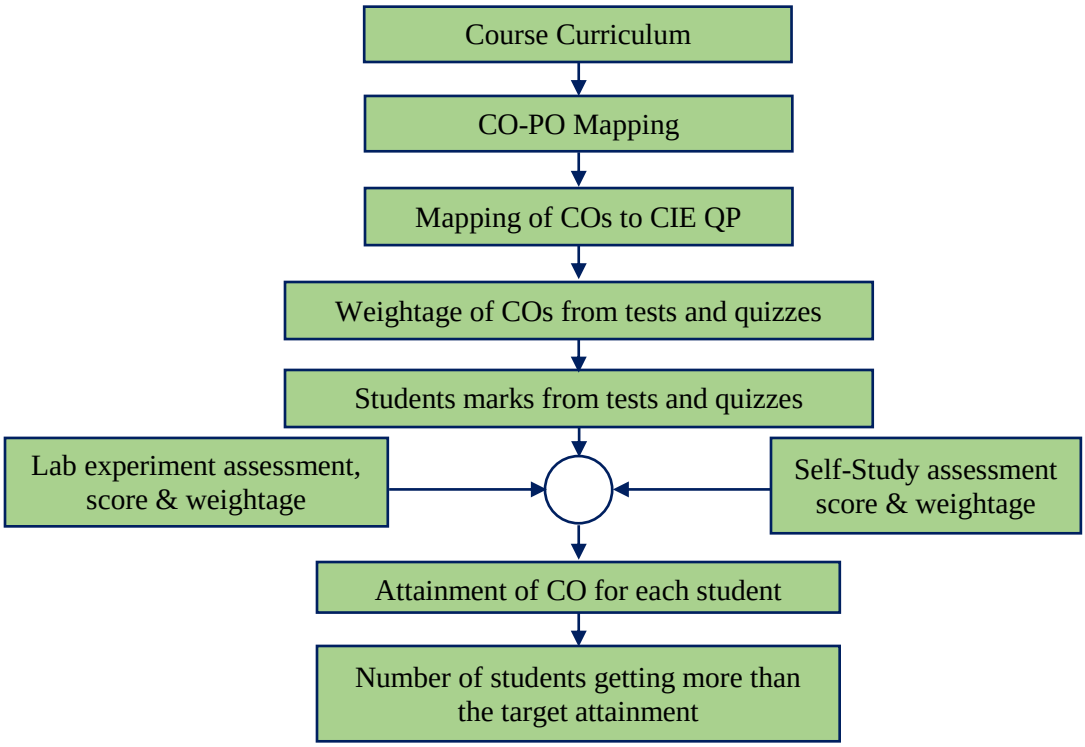
Curriculum Design Process



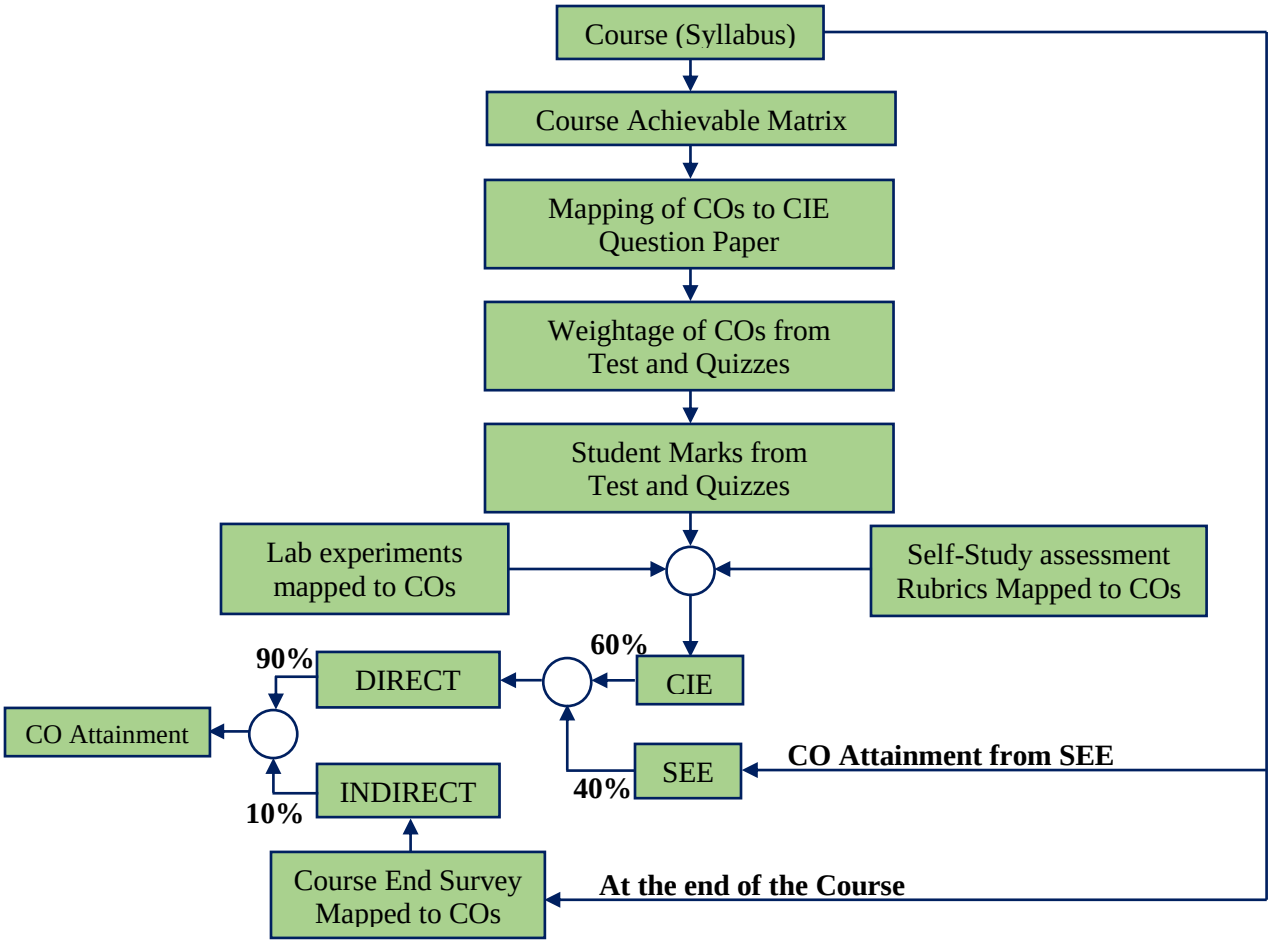
Academic Planning and Implementation



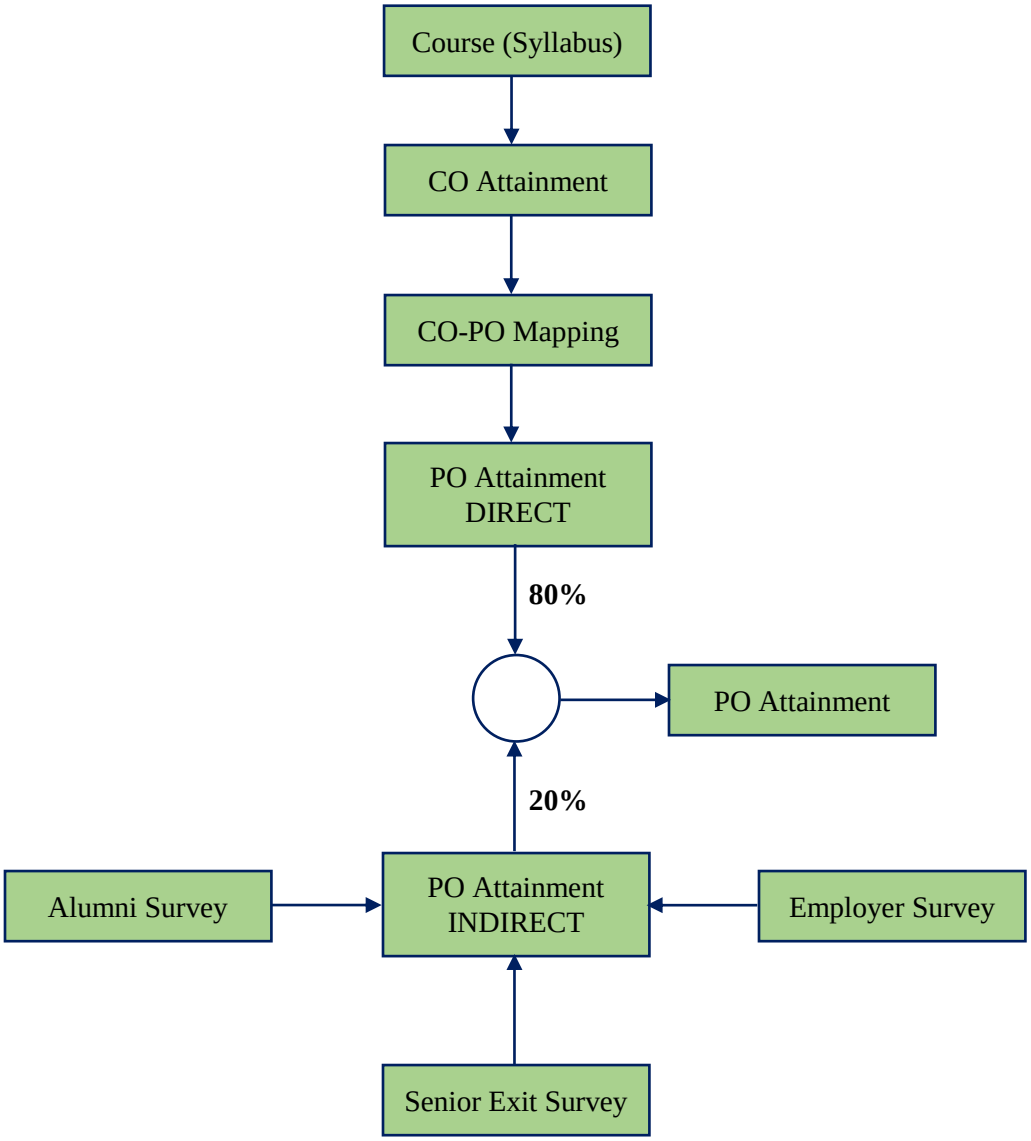
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



RV College of Engineering®
Mysore Road, RV Vidyaniketan Post,
Bengaluru - 560059, Karnataka, India

KNOWLEDGE & ATTITUDE PROFILE

- **WK1:** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
- **WK2:** Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
- **WK3:** A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
- **WK4:** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
- **WK5:** Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
- **WK6:** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
- **WK7:** Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
- **WK8:** Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
- **WK9:** Ethics, inclusive behaviour and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.