RV College of Engineering®

Master of Technology (M.Tech)

MACHINE DESIGN

Scheme And Syllabus of I to 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 Centers 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

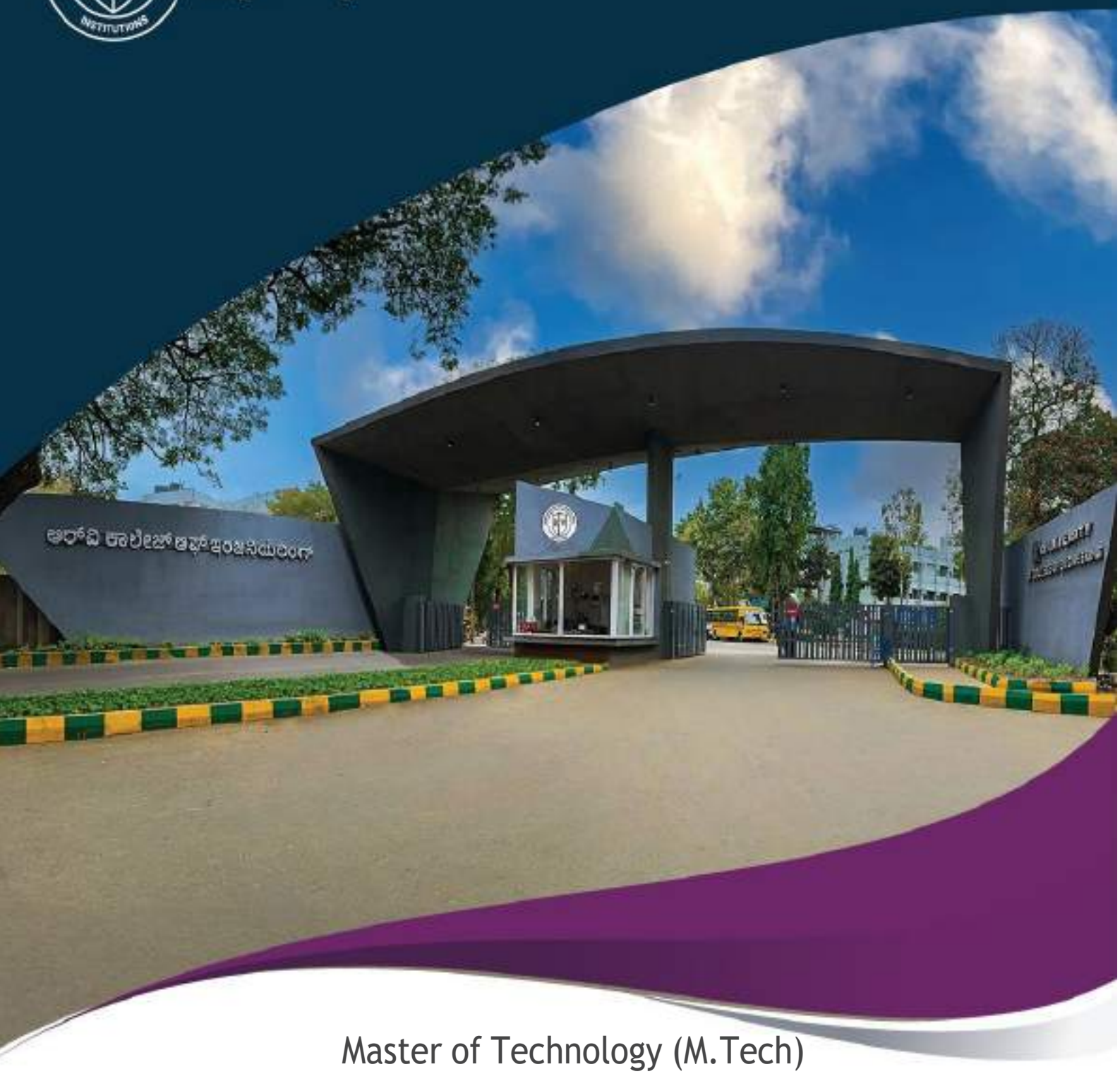
29
Skill Based Laboratories Across Four Semesters

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)

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2024
Edition

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

Quality education in Design, Materials, Thermal and Manufacturing with emphasis on research, sustainable technologies and entrepreneurship for societal symbiosis.

MISSION

1. Imparting knowledge in basic and applied areas of Mechanical Engineering.
2. Providing state-of-the-art laboratories and infrastructure for academics and research in the areas of design, materials, thermal engineering, and manufacturing.
3. Facilitating faculty development through continuous improvement programs.
4. Promoting research, education and training in materials, design, manufacturing, Thermal Engineering, and other multidisciplinary areas.
5. Strengthening collaboration with industries, research organizations and institutes for internship, joint research and consultancy.
6. Imbibing social and ethical values in students, staff and faculty through personality development programs.

PROGRAMME OUTCOMES (PO)

M. Tech in **Machine Design** graduates will be able to:

PO1: An ability to independently carry out research / investigation and development work to solve practical problems related to machine design.

PO2: An ability to write and present a substantial technical report / document.

PO3: An ability to demonstrate a degree of mastery over the areas of machine design. The mastery should be at a level higher than the requirements in the BE Mechanical Engineering and allied programs.

PO4: An ability to use modern tools for the design and analysis of static and dynamic systems and mechanisms.

PO5: An ability to adapt technical, safety, ethical and environmental factors in the design of system and mechanism.

PO6: An ability to perform in multidisciplinary teams with sound interpersonal and management skills with a commitment to lifelong learning.

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

INDEX

M.Tech in Machine Design: MMD												
I SEMESTER M.Tech												
Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
			L	T/ SDA	P	Total						
1	MMA211TA	Applied Mathematics	3	1	0	**4**	MA	Theory	1.5	100	3	100
2	MMD212IA	Composite Materials Engineering	3	0	1	**4**	ME	Theory+Lab	1.5	100+50	3	100+50
3	MMD213IA	Advanced Structural and Solid Mechanics	3	0	1	**4**	ME	Theory+Lab	1.5	100+50	3	100+50
4	XXX314AX	Professional Core Courses (Cluster Electives) **(Group-A)**	3	1	0	**4**	ME	Theory	1.5	100	3	100
5	MMD415SL	Skill Lab	0	0	2	**2**	ME	Lab	1.5	50	3	50
6	HSS116EL	Technical English	0	0	1	**1**	HSS	Lab (ONLINE)	1.5	50	--	--
Total Credits						**19**						

*Cluster-wise Courses Common to PG Programs

Clusters
CSE Cluster - PG Programs (CSE, CNE, SE, IT)
ECE Cluster - PG Programs (VLSI, CS, PE, DC)
ME Cluster - PG Programs (PDM, MD)
CV Cluster - PG Programs (ST, HT)
BT Cluster - PG Programs (BT)

Code	*Professional Core Courses (Cluster Electives)(Group A)
MPD314A1	Advanced Materials and Manufacturing Technology
MPD314A2	Electric & Hybrid Vehicle Engineering
MMD314A3	Machine Learning for Mechanical Systems
MMD314A4	Renewable Energy Systems

II SEMESTER M.Tech												
Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
			L	T/ SDA	P	Total						
1	MMD221IA	Vibration Engineering and Acoustical systems	3	0	1	**4**	ME	Theory+Lab	1.5	100+50	3	100+50
2	MMD222IA	Mechanisms and Dynamics in Engineering Design	3	0	1	**4**	ME	Theory+Lab	1.5	100+50	3	100+50
3	MMDX23BX	Program Specific Courses (Elective) **(Group-B)**	3	1	0	**4**	ME	Theory	1.5	100	3	100
4	MMDX24CX	Professional Core Courses (Cluster Electives) **(Group C)**	3	1	0	**4**	ME	Theory	1.5	100	3	100
5	XXX325DX	Interdisciplinary Courses (Global Electives) **(Group D)**	3	0	0	**3**	XX	Theory	1.5	100	3	100
6	MIM426RT	Research Methodology (NPTEL)	2	0	0	**2**	IM	NPTEL	--	--	ONLINE	100
7	MMD427DL	Design Thinking lab	0	0	2	**2**	ME	Lab	1.5	50	3	50
Total Credits						**23**						

Code	Program Specific Courses (Elective) (Group-B)
MMD323B1	Tribology for Mechanical Systems and Bearing Design
MMD323B2	Experimental Methods in Stress Analysis
MMD323B3	Vehicle Dynamics and System Modeling
MMD323B4	Reliability & Maintainability Engineering

Code	*Professional Core Courses (Cluster Electives) (Group – C)
MMD324C1	Non-linear finite element methods
MMD324C2	Non-Destructive Evaluation
MPD324C3	Interactive Design for Manufacture & Assembly
MPD324C4	Integrated Chip Manufacturing

*Cluster-wise Courses Common to PG Programs

Clusters

CSE Cluster - PG Programs (CSE, CNE, SE, IT)
ECE Cluster - PG Programs (VLSI, CS, PE, DC)
ME Cluster - PG Programs (PDM, MMD)
CV Cluster - PG Programs (ST, HT)
BT Cluster - PG Programs (BT)

****Open to all PG Programs**

****Interdisciplinary Courses- (Global Electives) (Group – D)**	
Course Code	Course Title
MBT325DA	Nature Impelled Engineering
MBT325DB	Clinical Data Management
MCN325DC	Cyber Forensics and Cyber Laws
MCV325DD	Industrial Safety and Health
MCV325DE	Advanced Technologies for Transportation Systems
MEC325DF	Design & Implementation of Human-Machine Interface
MEE325DG	Electric Vehicle Technology
MET325DH	Electronic Navigation Systems
MET325DJ	Vehicular Communication Ecosystem
MIM325DK	Essentials of Project Management
MIS325DM	User Interface & User Experience
MMA325DN	Mathematical Methods for Data Science
MME325DO	Industry 4.0: The Smart Manufacturing
MME325DQ	Industrial Internet of Things (IIoT)

III SEMESTER M. Tech												
Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
			L	T/ SDA	P	Total						
1	MMD231TA	Fatigue & Fracture Mechanics	3	1	0	**4**	ME	Theory	1.5	100	3	100
2	MMDX32EX	Professional Elective Course (**NPTEL**) **(Group – E)**	2	0	0	**2**	ME	NPTEL	--	--	ONLINE	100
3	MMD433P	Minor Project	0	0	6	**6**	ME	Project	1.5	50	3	50
4	MMD434N	*Industry Internship/Research Internship/ Projects in CoEs	0	0	6	**6**	ME	Internship	1.5	50	3	50
Total Credits						**18**						

***To be undertaken after completion of 2nd Sem and before commencement of 3rd Semester (8 weeks duration)**

Code	Professional Elective Course (NPTEL) (Group – E)
MMD332E1	Design Practice – I
MMD332E2	Design for Mechanical Transmission System
MMD332E3	Dynamic Behaviour of Materials
MMD332E4	Experimental Modal Analysis

IV SEMESTER M. Tech in Machine Design												
Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	CIE Duration (H)	Max Marks CIE	SEE Duration (H)	Max Marks SEE
			L	T/ SDA	P	Total						
1	MMD441FX	Program Specific Courses (NPTEL -Elective) (Group F)	2	0	0	**2**	ME	NPTEL	--	--	ONLINE	100
2	MMD442P	Major Project	0	0	18	**18**	ME	Project	--	100	3	100
Total Credits						**20**						

Code	Program Specific Courses (NPTEL -Elective) (Group F)
MMD441F1	Design Practice – II
MMD441F2	Fundamentals of Artificial Intelligence
MMD441F3	Heat exchangers – Fundamentals & Design Analysis
MMD441F4	Machinery Fault Diagnosis and Signal Processing

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+30T+45EL	*(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. **(PO1)**
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. **(PO1, PO4)**
CO3	:	Analyze the solution of the engineering problems solved using appropriate techniques of random variables, probability distributions, sampling theory, statistics optimization and numerical methods. **(PO1, PO4, PO5, PO6)**
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. **(PO1, PO4, PO5, PO6)**

Reference Books
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, 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	:	**MMD212IA**	**Composite Materials Engineering**	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 Hours

UNIT - I	**9 Hours**
Introduction to Composite Materials: Definition, Classification: Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Natural composites, and applications. Fibres- Glass, Silica, Kevlar, carbon, boron, silicon carbide, and natural fibers – jute, kenaf, bamboo, ramie etc. **Particulate composites**, Thermoplastics, Thermosets, Sandwich composites. Advantages and Limitations of composite materials. Properties of composites in comparison with standard materials.	
UNIT - II	**9 Hours**
Elastic behavior of Composite Lamina: Introduction – Lamina, Laminate, Rule of Mixtures, Evaluation of the Four Elastic Moduli, Strength of Materials Approach, Numericals, Micromechanical analysis of a lamina - Volume and Mass Fractions, Density, and Void Content. Ultimate strength of uni-directional lamina. **Mechanical & Dynamic Properties -** Stiffness and Strength, Mechanical Testing: ASTM Standards - Determination of stiffness and strengths of unidirectional composites; tension, compression, flexure and shear. Modal testing of composite structures	
UNIT - III	**8 Hours**
Failure, Design of Lamina and laminates: Basic assumptions, laminate code, Strength Failure Theories of an Angle Lamina: Maximum Stress Failure Theory, Strength Ratio, Failure Envelopes, Failure theories: Maximum Strain Theory, Tsai–Hill, Theory, Tsai–Wu Theory & Hoff man theory, Hashin Theory **Laminate:** Special Cases of Laminates, and Failure Criterion for a Laminate, and Design of a Laminated Composite. A, B, D matrix and significance	
UNIT - IV	**8 Hours**
Manufacturing methods: Hand and spray lay - up, vacuum bagging, injection molding, resin injection, filament winding, pultrusion, centrifugal casting and prepregs. Autoclave method of curing composites. 3D printing of composites – Additive manufacturing **Applications of composite materials:** Aerospace, aircraft structures and components, Automotive, Marine, Sports & consumer products	
UNIT - V	**8 Hours**
Nanocomposites: General introduction to nanocomposites; Materials, particulate, clay, and carbon nanotube, graphene nanocomposites, synthesis, characterization, properties, and applications. Neural network learning in composites design **Recycling of composites:** Mechanical recycling, chemical recycling, and pyrolysis techniques. Recycling of carbon composites, glass composites, automotive and aerospace composites	

LABORATORY	28 Hours

1. Preparation of composite laminates using simple hand lay-up technique
2. Mechanical testing of laminates as per ASTM standards – Tensile, Compression & Flexural
3. Drop weight Impact testing of Composite laminates
4. Modal testing of composite laminates under different boundary conditions
5. Hardness testing of laminates
6. Four Point Bending test of Sandwich composite as per ASTM standards
7. NDT of composite laminates – Ultrasonic test method to detect thickness and flaws
8. Izod/Charpy impact testing of composite laminates
9. Adhesive bonding /joining of composite laminates and testing for bond strength
10. Three Point Bend or Short beam test to assess the shear properties of composite laminate

Course Outcomes:

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

CO1	:	Understand the fundamentals of composites, definition & classification of composites in comparison with standard materials
CO2	:	Analyze elastic behavior and dynamic properties of composite materials applying basic laws in mechanics to the composite materials
CO3	:	Apply different manufacturing techniques for composite materials & comprehend their applications if various sectors
CO4	:	Understand the basics of nanomaterials & bio-composites and their properties & applications.

Reference Books

1. Autar K. Kaw “Mechanics of Composite Materials”, CRC Press, 2nd Edition, 2010. ISBN 0–8493–1342-0
2. Mein Schwartz, Composite Materials Handbook, McGraw Hill Ed, 4th Edition, 1992, ISBN 0-007557438
3. Rani Elhajjar, Valeria La Saponara, Anastasia Muliana, “Smart Composites Mechanics and Design”, CRC Press, 1st Edition, 2014, ISBN 9781138075511
4. Ramanan Krishnamoorti, “Polymer nanocomposites: synthesis, characterization, and modeling”, American Chemical Society: Distributed by Oxford University Press 2002, ISBN 9491358265321
5. Vannessa Goodship, “Management, recycling and reuse of waste composites” CRC Press, Published by Woodhead Publishing Limited, 2010, ISBN 978-1-4398-0104-8

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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	10
	SEE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE SEE	**150**

SEMESTER: I						
Course Code	:	**MMD213IA**	**Advanced Structural and Solid Mechanics**	CIE Marks	:	50
Credits L-T-P	:	3-0-1		SEE Marks	:	50
Hours	:	45L+45EL+30P	*(Professional Core Course with Integrated Lab) -2*	SEE Durations	:	3 Hrs

UNIT - I	**9 Hrs**

Theories of Stress: Body Force, Surface Force and Stress Vector, The state of stress at a point, normal and shear stress, rectangular stress components, stress components on an arbitrary plane, principal stresses,
Stress Invariants, Mohr's circle for the Three-Dimensional Stress condition, Octahedral stresses. Decomposition into Hydrostatic and Pure Shear States, Equilibrium equations for plane stress state in Cartesian coordinate system.

UNIT - II	**9 Hrs**

Theories of Strain: Deformation in the neighbourhood of a point, change in length of a linear element, change in length of linear element – linear components, Rectangular Strain Components,
State of Strain at a Point, Principal Strains and strain invariants, Plane State of Strain, Strain Deviator and its Invariants. Compatibility Conditions.

UNIT - III	**8 Hrs**

Stress–Strain Relations: Generalised statement of hook's law, Stress – strain relation for isotropic materials, Relation between the elastic constants.
Ideally Plastic Solids: The Deviatoric Plane or the π Plane, General Nature of the Yield Locus, Yield Surfaces of Tresca and Von Mises, Stress–Strain Relations (Plastic Flow), Prandtl–Reuss Equations, Saint Venant–Von Mises Equations.

UNIT - IV	**8 Hrs**

Energy Methods: Work done by forces and elastic strain energy stored, Reciprocal relation. Maxwell-Betti-Rayleigh reciprocal theorem, First Theorem of Castigliano, Expressions for Strain Energy, superposition of elastic energies.
Bending of Beams: Introduction, Straight Beams and Asymmetrical Bending, Regarding Euler–Bernoulli Hypothesis, Shear Centre or Centre of Flexure.

UNIT - V	**8 Hrs**

Linear elastic solutions: Torsion of General Prismatic Bars–Solid Section, Prandtl elastic membrane (Soap-Film) analogy, Torsion of Thin-Walled Tubes, Torsion of Thin-Walled Multiple-Cell Closed Sections, Centre of Twist and Flexural Centre.
Thermal stresses: Thermo-elastic Stress–Strain relations, Equations of Equilibrium, Strain–Displacement relations, Some General Results.

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

CO1	Identify the stress-strain relations in elastic and plastic conditions.
CO2	Examine bodies subjected to three dimensional stresses for the onset of failure based on failure criteria.
CO3	Analyze deflections in beams subjected to different types of loads for elastic, elastoplastic and plastic conditions.
CO4	Evaluate stresses in bars subjected to torsion for elastic, elastoplastic and plastic conditions.

	LABORATORY	28 Hours
1.	Materials database preparation for isotropic, orthotropic and anisotropic type.	
2.	Plate with a Hole for ductile and brittle materials subjected to quasi-static loading	
3.	Bending stress in a cantilever beam of rectangular cross section subject to inclined load.	
4.	Fatigue analysis of plane stress specimen subjected to in-plane tensile load	
5.	Buckling Analysis of Fixed – Free column	
6.	Shear stress analysis of torsional shaft subjected to torsion.	
7.	Thermal stress analysis of circular bar for coupled field conditions	
8.	Contact stress evaluation for pin-on-disc condition	
9.	Stress analysis for composite materials subjected to quasi-static loading	
10.	Stress Intensity Factor for circumferential cracks in cylinders	

References

1.	L. S. Srinath, Advanced Mechanics of solids, 2000, Tata Mc. Graw Hill, ISBN-13: 978-0070702608, 2009
2.	S. P. Timoshenko, Theory of Elasticity, Mc. Graw Hill, 3rd edition, ISBN 978-0-13-223319-3, 1972
3.	M. A. Kazimi, Solid Mechanics, Tata McGraw-Hill, 2001, 0074517155, 9780074517154
4.	Boresi & Sidebottom, "Advanced Mechanics of materials, Wiley International, 6th edition
5.	Dr Sadhu Singh, Strength of materials" Khanna Publication, 1st 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**
	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	10
SEE LAB TOTAL		**50**
MAXIMUM MARKS FOR THE SEE		**150**

SEMESTER: I						
Course Code	:	**MPD314A1**	**Advanced Materials and Manufacturing Technology**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Professional Core Courses (Cluster Electives) (Group-A)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**

Introduction to Advanced Materials: Categories of Advanced Materials: Overview of composites, ceramics, polymers, and high-performance alloys., Smart Materials: Shape memory alloys, piezoelectric materials, thermoelectric materials, and self-healing materials.
Biomaterials and Bioinspired Materials: Applications in medical devices, tissue engineering, and bio-mimetic design. Material Characterization Techniques: SEM, TEM, XRD, AFM, and spectroscopy for structural and surface analysis.

UNIT - II	**9 Hours**

Advanced Manufacturing Processes for Metals and Alloys: Additive Manufacturing (AM): Types of AM processes (SLS, SLA, FDM, DMLS) and applications in metals and alloys, Powder Metallurgy: Powder production, compaction, sintering, and applications in aerospace and automotive industries, High-Performance Casting Techniques: Investment casting, die casting, and continuous casting for precision components. High-Energy Beam Processing: Applications of laser, electron beam, and plasma arc in cutting, welding, and surface modification.

UNIT - III	**8 Hours**

Polymer Materials: Thermoset, Thermoplastics and Elastomers applications. Composite Materials: Classification, PMC, MMC, CMC, Applications. Polymer and Composite Manufacturing Processes Polymer Processing Techniques: Injection molding, blow molding, extrusion, and 3D printing of polymers. Thermoset vs. Thermoplastic Processing: Methods and applications in automotive, aerospace, and consumer goods. Composite Fabrication Techniques: Layup processes, filament winding, resin transfer molding (RTM), and pultrusion.

UNIT - IV	**8 Hours**

Advanced Joining Techniques for Composites: Adhesive bonding, ultrasonic welding, and mechanical fastening. Non-Destructive Testing (NDT): Techniques such as ultrasonic testing, radiography, magnetic particle testing, and dye penetrant testing.

UNIT - V	**8 Hours**

Sustainable Manufacturing Systems and Industry Practices, Lean Manufacturing and Sustainability: Reducing waste and maximizing efficiency through lean practices. Green Supply Chain Management: Sustainable sourcing, procurement, and logistics management. Environmental Management Systems (EMS): ISO 14000 standards, implementation, and benefits. Sustainability Metrics and Reporting: Key Performance Indicators (KPIs) for sustainability in manufacturing. Global Sustainable Manufacturing Initiatives: Overview of international standards, regulations, and corporate sustainability practices.

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

CO1	:	Explain the role of JIT, TPS and TQC strategies in production system
CO2	:	Analyze the various concepts of modern manufacturing practices
CO3	:	Apply the concepts of JIT and TPS in real time applications
CO4	:	Acquire knowledge in branding

Reference Books
1.M. Addington and D. Schodek, Smart Materials and Technologies: For the Architecture and Design Professions. Oxford, UK: Architectural Press, ISBN 0 7506 6225 5, 2005
2. W. D. Callister and D. G. Rethwisch, Materials Science and Engineering: An Introduction, 10th ed. Hoboken, NJ, USA: Wiley, ISBN-13: 9781119321590, 2018
3. K.K.Chawla, Composite Materials: Science and Engineering, 3rd ed. Springer Publisher, ISBN 9780387743646, 2012
4. A Ahmad and L J Bond, ASM Handbook, Volume 17: Non-destructive Evaluation of Materials; ASM International, ISBN-13: 978-1-62708-153-5, 2018
5. G. Seliger, Sustainable Manufacturing: Challenges, Solutions and Implementation Perspectives 1st Editon, Springer, [Online]. Available: https://doi.org/10.1007/978-3-642-27290-5, 2012

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	:	**MPD314A2**	**ELECTRIC AND HYBRID VEHICLE ENGINEERING**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*(Professional Core Courses (Cluster Electives) (Group-A)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Overview of EVs and challenges: Components of EVs - architecture of EVs - EV market and Promotion-infrastructure needs - EV makers - Comparison in reference of: Energy source, Pollution, Energy diversification, Efficiency, Capital & operating cost, Performance. Classifications: Classification of EVs in reference to: Propulsion devices, Energy sources, Energy carriers, Pure Electric Vehicles (PEV) - Hybrid Electric Vehicles (HEV) and Plug-in Hybrid Electric Vehicles (PHEV) - Configurations: BEV, FCEV	
UNIT - II	**9 Hours**
Design Considerations: Aerodynamic Considerations, Rolling Resistance, Transmission Efficiency, Consideration of Vehicle Mass, Electric Vehicle Chassis and Body Design, Issues in Design. Design of Ancillary Systems: Heating and Cooling Systems, Design of the Controls, Power Steering, Choice of Tyres, Wing Mirrors, Aerials and Luggage Racks, Electric Vehicle Recharging and Refuelling Systems. Electric Vehicle Modelling: Tractive Effort, Modelling Vehicle Acceleration, Modelling Electric Vehicle Range, Numerical.	
UNIT - III	**8 Hours**
Batteries, Flywheels and Supercapacitors: Battery Parameters, Lead Acid Batteries, Nickel-Based Batteries, Sodium-Based Batteries, Lithium Batteries, Metal–Air Batteries, Supercapacitors and Flywheels, Battery Charging, The Designer's Choice of Battery, Batteries in Hybrid Vehicles, Battery Modelling, Battery Management Systems. Fuel Cells: Hydrogen Fuel Cells, Thermodynamics, Connecting Cells in Series, Water Management in the PEMFC, Thermal Management of the PEMFC, Fuel Cell System, Practical Efficiency of Fuel Cells, Hydrogen as a Fuel- Reforming, Efficiency, Storage.	
UNIT - IV	**8 Hours**
EV Drives: BEV, HEV, FCEV, EV motor drive technologies - IC engine vehicle force - speed characteristics (5-gears), BEV force - speed characteristics (fixed gears) - Comparison between ICE vehicles & BEV - Requirement of EV motor compared to industrial motors - classification of EV motors (DC, Induction, BLDC, PMSM) – Types, Principle, Construction, Control - Electric Drive Train and its types and Power Converters.	
UNIT - V	**8 Hours**
Types of Chargers: AC charging and DC charging - On board and off board charger specification - Type of Mode of charger Mode 2, Mode 3 and Mode 4 - EVSE associated charging time calculation - Selection and sizing of fast and slow charger (AC & DC) - AC Pile Charger, DC Pile Charger. Modelling and Vehicle Dynamic Control: Modelling and Characteristics of EV/HEV Powertrains Components - ICE Performance Characteristics - Electric Motor Performance Characteristics - Battery Performance Characteristics -Transmission and Drivetrain Characteristics - Regenerative Braking Characteristics. Control of Electric and Hybrid Electric Vehicle Dynamics - Fundamentals of Vehicle Dynamic Control (VDC) Systems - VDC Implementation on Electric and Hybrid Vehicles.	

Course Outcomes:		
After going through this course the student will be able to:		
CO1	:	Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and modelling.
CO2	:	Discuss and implement different energy storage technologies used for electric vehicles and their management system
CO3	:	Analyze various electric drives and its integration techniques with Power electronic circuits suitable for electric vehicles.
CO4	:	Analyse the requirement for model-based EV designs and its infrastructure needs.

Reference Books

1. James Larminie, John Lowry, "Electric Vehicle Technology Explained", Wiley Publisher, 2nd Edition, 2012, 2nd Edition ISBN:9781119942733.
2. Iqbal Hussain, "Electric & Hybrid Vehicles –Design Fundamentals", Second Edition, CRC Press, 2011, ISBN 0-8493-1466-5
3. Davide Andrea, "Battery Management system for large Lithium Battery Packs", ARTECH HOUSE 4th Edition 2010, ISBN-13 978-1-60807-104-3
4. F. BADIN, Ed, Hybrid Vehicles from Components to System", Editions Technip, Paris, 2013, 3rd Edition, 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: I						
Course Code	:	**MMD314A3**	**Machine Learning for Mechanical Systems**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*Professional Core Courses (Cluster Electives) (Group-A)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Introduction to Machine Learning, history of machine learning, artificial intelligence vs machine learning, data science vs machine learning, decision tree, Naive Bayes approach	
UNIT - II	**9 Hours**
Learning Models, Types of Learning: Supervised, Unsupervised, Reinforcement, Perspectives and Issues, Version Spaces, PAC Learning, VC Dimension	
UNIT - III	**8 Hours**
Regression: Linear Regression, Multiple Linear Regression, Bayesian Regression, Neural Networks: Introduction, Perception, Multilayer Perception, Support Vector Machines: Linear and Non-Linear, Kernel Functions, K nearest Neighbours. Introduction to clustering, K-means clustering, K-Mode Clustering.	
UNIT - IV	**8 Hours**
Genetic Algorithms: Hypotheses, Genetic Operator, Fitness Function and Selection, an Illustrative Example, Hypothesis Space Search, Genetic Programming, Parallelizing Genetic Algorithms.	
UNIT - V	**8 Hours**
Smart machining: application of neural networks, genetic algorithm for turning, milling, drilling and robotic applications, sensing, monitoring, data analysis, parameters, interpretation of responses	

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

CO1	:	Understand the basics of probability distributions and components of learning.
CO2	:	Develop the regression models and algorithms for mechanical applications
CO3	:	Assess the solution using advanced optimisation techniques.
CO4	:	Predict the responses from neural network and genetic algorithms for smart machining applications.

Reference Books

1.Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Prentice Hall of India, 3rd Edition 2014, ISBN: 9780262028189.
2.Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar” Foundations of Machine Learning”, MIT Press, 2012, ISBN: 9780262039406
3.Tom Mitchell, “Machine Learning”, McGraw Hill, 3rdEdition, 1997, ISBN 0070428077
4.MACHINE LEARNING - An Algorithmic Perspective, Second Edition, Stephen Marsland, 2015, ISBN:9781466583283

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	:	**MMD314A4**	**Renewable Energy Systems**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*Professional Core Courses (Cluster Electives) (Group-A)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**

Introduction: Overview of Energy Resources: Conventional vs. Renewable energy resources, global and Indian energy scenario. Principles of Renewable Energy: Concepts of sustainability, energy efficiency, and carbon footprint. Policies and Incentives: National and international frameworks for renewable energy adoption.

UNIT - II	**9 Hours**

Solar Energy: Solar Radiation: Basics, measurement, and solar angles. Photovoltaic Technology: Solar cells, PV modules, and applications. Solar Thermal Systems: Flat plate collectors, concentrating collectors, and solar water heating systems. Economic and Environmental Impact: Cost analysis and CO_2 savings.

UNIT - III	**8 Hours**

Wind Energy: Fundamentals of Wind Energy: Wind characteristics and power estimation. Wind Turbine Technology: Types, aerodynamics, and components. Wind Farm Development: Site selection, grid integration, and environmental impact. Use of QBLADE Software: Simulation and analysis of wind turbine performance. Case Studies: Successful wind energy projects in India and abroad.

UNIT - IV	**8 Hours**

Bioenergy: Biomass Resources: Types, availability, and conversion technologies. Biogas Technology: Design, operation, and applications. Biofuels: Types, production, and role in energy security. Waste-to-Energy: Technologies and case studies.

UNIT - V	**8 Hours**

Hydrogen Energy: Basics of Hydrogen Energy: Production, storage, and transportation. Fuel Cell Technology: Types, working principles, and applications. Hydrogen Economy: Opportunities and challenges. Integration with Renewable Energy Systems: Role of hydrogen in energy storage and grid stabilization.

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

CO1	:	Evaluate energy scenarios and Develop solutions for sustainability challenges using renewable technologies.
CO2	:	Assess their feasibility for integration and storage applications.
CO3	:	Analyze energy systems using tools and optimize their performance.
CO4	:	Formulate strategies to utilize emerging renewable technologies.

Reference Books

1. Godfrey Boyle, “Renewable Energy: Power for a Sustainable Future”, Oxford University Press, 2nd Edition, 2004. ISBN: 978-8-12-240947-5
2. Soteris A. Kalogirou, “Solar Energy Engineering”, Academic Press, 2nd Edition, 2013. ISBN: 9780123972705
3. J.F. Manwell, J.G. McGowan, A.L. Rogers, “Wind Energy Explained: Theory, Design, and Application”, Wiley, 2nd Edition, 2009. ISBN: 978-0-47-001500-1

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	:	**MMD415SL**	**Skill Lab**	CIE Marks	:	50
Credits L-T-P	:	0-0-2	*(Design Thinking/ Skill Lab)*	SEE Marks	:	50
Hours/Week	:	4	*(Practice)*	SEE Duration	:	2 Hrs

Modules

1. Study of 3D-Printing & Ender print parameters in UltiMaker Cura, Modelling the components using CAD software
2. Calibration of 3D printer setup, Printing ASTM standard specimens for Impact test, Tensile test and drop test.
3. Post processing the 3D-printed components by removal of supports and rough edges, Checking the dimensions and mass of the specimens.
4. Performing the mechanical characterization, including impact test, tensile test, and drop test
5. Exploring Surface preparation using Laser polishing and surface morphology using Optical microscope
6. Exploring Centre of Excellence of MG-Electric vehicle technology and performing simple experiments

Course Outcomes:

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

CO1	:	Demonstrate knowledge of 3D printing technology by understanding printer parameters in Ultimate Cura and modeling components using CAD software.
CO2	:	Calibrate 3D printer setups and fabricate ASTM standard specimens for mechanical testing, including impact, tensile, and drop tests.
CO3	:	Apply post-processing techniques to improve the quality of 3D-printed components by removing supports, refining surfaces, and verifying dimensional accuracy and mass.
CO4	:	Analyze the mechanical properties and surface characteristics of 3D-printed specimens through mechanical characterization tests and advanced surface preparation techniques like laser polishing.

Reference Books

1. Ian Gibson, David W. Rosen, Brent Stucker, "Additive Manufacturing Technologies" Springer New York, NY, 1st Edition, 2010, ISBN: 978-1-4419-1119-3
2. Chee Kai Chua, Kah Fai Leong, "3D Printing and Additive Manufacturing", World Scientific press, Fifth Edition, 2020, ISBN: 978-981-3146-75-4 (hardcover)
3. Harshit K. Dave, J. Paulo Davim, "Fused Deposition Modeling Based 3D Printing", Materials Forming, Machining and Tribology- Springer, First Edition 2021, ISBN-13-978-3030680237
4. William M. Steen , Jyotirmoy Mazumder, "Laser Material Processing", Springer New York, NY, 4th Edition, 2010, ISBN: 978-1-84996-061-8

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 CIE	**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**	CIE Marks	:	50
Credits L-T-P	:	0-0-1	*(online-Lab)*	SEE Marks	:	50
Hours/Week	:	30L	*(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. Board of Editors "Contemporary Communicative English for Technical Communication" Pearson Education in South Asia. 2011, ISBN: 978-81-317-5590-7
3. Mark Ibbotson "Professional English in Use – Engineering Technical English for professionals" Cambridge University Press, New Delhi, 2009, ISBN 978 – 0 – 521 – 73488 – 2
4. Adrian Wallwork, "User Guides, Manual, and Technical Writing – A Guide to Professional English, Springer publisher, 2014, ISBN 978 – 1 – 4939 – 0640 – 6

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	:	**MMD221IA**	**Vibration Engineering & Acoustical Systems**	CIE Marks	:	100 + 50
Credits L-T-P	:	3-1-0	*(Theory & Practice)*	SEE Marks	:	100 + 50
Hours	:	45L+45EL+30T	*(Professional Core Course with Integrated Lab) -1*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Fundamentals of vibration – Basic concept of vibration, Importance of the study of vibration, Classification of vibration, Vibration analysis procedure, Simple Harmonic Motion, Addition of two harmonics (analytical and graphical method) **Free Vibration of Single Degree Freedom Systems** – Free vibration of undamped systems, Equation of motion, Springs in series & parallel, Effect of mass of spring, Numerical.	
UNIT - II	**9 Hours**
Damped Free Vibration – Types of damping, over, critical and under damped systems, Logarithmic decrement, vibration energy and logarithmic decrement. **Harmonically excited Vibration** – Introduction, Equation of motion, Response of an underdamped system under harmonic force, Response of a damped system under harmonic force, Forced vibration with coulomb damping, hysteresis damping, and other types of damping.	
UNIT - III	**8 Hours**
Vibration Control – Introduction, Vibration severity, ISO recommendations, Reduction of vibration at the source, Whirling of rotating shafts, vibration isolation, vibration absorbers. **Vibration Measuring Instruments** – Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Frahm's Reed Tachometer, Fullerton tachometers, Vibration exciters	
UNIT - IV	**8 Hours**
Finite Element Dynamic Analysis – Introduction, Eigen value Analysis, Axial vibrations of bar element, Transverse vibrations of beams, Numerical examples **Determination of Natural Frequencies**, Damping & Mode Shapes – Influence coefficient, Rayleigh's Method & Dunkerley's method, Experimental Modal testing of structures	
UNIT - V	**8 Hours**
Fundamentals of Acoustics – Basics of Acoustics, Human perception of sound, sound pressure and sound pressure level, Sound wave propagation in 1D, Acoustic quantities and relations, Additive effects of sound. Acoustic transducers – parameters to be considered in the choice of microphones; types of microphones **Human vibration** – Human vibration - Hand Arm Vibration, Whole Body Vibration – basic concept & modelling	

	LABORATORY 28 Hours
1.	Whirling of shafts with different shaft diameters – Analyze the speed at which a rotating shaft will tend to vibrate violently in the transverse direction if the shaft rotates in horizontal direction.
2.	Longitudinal vibration of spring mass system (with & without damping) - The study of the dynamical behavior of longitudinally vibrating rods with and without damping.
3.	Torsional vibration of spring mass system (with & without damping) - The study of the dynamical behavior of torsional vibrating discs with & without damping
4.	Estimation of damping in a cantilever beam using FRF Curve – Accurate evaluation of flexural vibration damping of cantilever beam using Frequency Response Function (FRF).
5.	Determination of natural frequency & damping of SDOF system using MAT LAB code - Analyze the damping ratio, natural frequency, and time constant of the poles of the linear SDOF system.
6.	Modal testing of cantilever beam using FFT Analyzer - Analyze the natural frequency and modal shapes of cantilever beam using FFT analyzer.
7.	Modal testing of plate under free-free condition using FFT Analyzer - Analyze the natural frequency and modal shapes of plate under free-free condition using FFT analyzer.
8.	Modal testing of a composite plate using FFT Analyzer - Analyze the natural frequency and modal shapes of composite plate using FFT analyzer
9.	Measurement of Frequency Response Function (FRF) using modally tuned shaker
10.	Noise Level Measurement at different locations using Noise Meter

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

CO1	:	Understand the fundamentals of vibration in single degree of freedom system by applying Newton's law of motion
CO2	:	Model the undamped and damped mechanical systems & structures
CO3	:	Apply concepts of vibration control and instrumentation based on ISO recommendations. Select numerical methods to determine modal parameters
CO4	:	Comprehend the basics of acoustics including sound propagation and human perception of sound and effects of human vibration on health and safety

Reference Books

1. S S Rao, 'Mechanical Vibrations', Pearson Publisher, 6th Edition, ISBN 978-0-13-212819-3, 2016
2. C Sujatha, 'Vibration and Acoustics ', McGraw Hill Education, ISBN 978-007014878, 2017
3. Jyoti Kumar Sinha, 'Vibration Analysis, Instruments, and Signal Processing', CRC Press, Taylor & Francis Group, New York, ISBN 78-1-4822-3145-8, 2015
4. Rao V Dukkipati, 'Solving Vibration Analysis Problems using MATLAB', New Age International Publishers, ISBN 978-81-224-2427-0, 2007

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	10
	SEE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE SEE	**150**

SEMESTER: II						
Course Code	:	**MMD222IA**	**Mechanisms & Dynamics in Engineering 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) -1*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Classical Dynamics-1: Mechanical Systems and Generalized Coordinates, Constraints and the principle of virtual work to analyse system behaviour. Generalized forces, energy, and momentum, **Lagrange's Equation:** Derivation of Lagrange's equations and their application. Practical problems include analysis of the simple pendulum, double pendulum, particle motion in a whirling tube, and a particle with machinery support.	
UNIT - II	**9 Hours**
Classical Dynamics-2: Hamilton's Principle, derivation of Hamilton's equations and the structure of Hamiltonian functions with relevant problem-solving applications. **Hamilton-Jacobi Theorem**, Hamilton's principal function, and the Hamilton-Jacobi equation, along with Mobi's Theorem for a comprehensive understanding of advanced mechanics.	
UNIT - III	**8 Hours**
Synthesis of Mechanisms: -1 Analytical Method: Type, Number and Dimensional Synthesis, Function Generation, path Generation and Body Guidance, Design of a slider-crank mechanism, Four-bar crack rocker mechanism, Crank-Rocker mechanism with optimum Transmission Angle, Precision points for Function Generation, Structural Error, Chebychev Spacing, **Frudenstein's Equation** for both four bar and slider-crank mechanism, Bloch's Method of Synthesis Analytic Complex Number Modeling in Kinematic Synthesis, The Dyad or Standard Form, Problems	
UNIT - IV	**8 Hours**
Synthesis of Mechanism: -2 Graphical Method: Dead Center problems (Slider-crank and Crack-Rocker mechanisms), Synthesis of a Quick-Return Mechanisms, Crank-Rocker Mechanisms with optimum Transmission Angle, Three-position Synthesis, Four-Position Synthesis (Point-Position Reduction) **Overlay Method**, Motion Generation Mechanism coupler as the output (two positions, Three position), Coupler-Curve Synthesis (two position, Four positions, Five position), Rober-Chevschev synthesis, Pole, Relative pole, Synthesis of Four bar and slider crank mechanism (Two position and Three position), Problems	
UNIT - V	**8 Hours**
Synthesis of Mechanism-3: Spatial Mechanism (3D): Introduction, Exceptions in the Mobility of Mechanisms, The Position-Analysis Problem, **Eulerian Angles**, introduction to Robotics, Topology arrangements of robotic arms, Forward Kinematics, Inverse Position Analysis, Inverse Velocity and Acceleration Analyses.	

LABORATORY	28 Hours

1. **Freely Falling Body**: Simulate and plot the motion of a free-falling body (point mass) with specified mass and inertia along the y-axis over a 2-second period.
2. **Inclined Plane:** Simulate the rate at which an object slides down an inclined plane, demonstrating the effect of surface tilt on sliding speed.
3. **Lift Mechanism – Geometry**: Implement general multibody system dynamics for a scissor lift mechanism (four-bar parallel mechanism) using a bond graph modeling framework.
4. **Lift Mechanism – Simulation:** Simulate the lift mechanism with designed geometry and functional parameters.
5. **One-Degree-of-Freedom Pendulum:** Perform motion analysis to study the center of mass and natural frequency of the pendulum, including angle measurement
6. **Projectile Motion:** Explore projectile motion by modifying initial conditions and observing changes in motion.
7. **Spring-Damper System - Part 1:** Simulate a single mass on a spring attached to a wall as a simple linear oscillator; adjust mass, spring stiffness, and damping
8. **Spring-Damper System - Part 2:** Repeat the spring-damper simulation under varied conditions for comparison.
9. **Four-Bar Mechanism:** Model a planar four-bar linkage with rigid rods connected by pin joints for kinematic analysis
10. **Crank Slider Mechanism:** Demonstrate the 1-DOF slider-crank mechanism, analyzing its motion.

Course Outcomes:

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

CO1	:	Understand the classical dynamics of Lagrangian, Hamilton-Jacobi, & Mobi principles
CO2	:	Synthesize mechanisms for their dimensions by analytical method
CO3	:	Estimate the dimensions of mechanisms by graphical method
CO4	:	Illustrate the process for the development of spatial and robotic mechanisms

Reference Books

1.George N Sandoor / Arthur G. Erdman, “Advanced Mechanism Design Analysis and Synthesis” 2nd Edition, Pearson Publisher, 2010 ISBN 0-13-011437-5

2.John J Uicker Jr. Gordon R. Pennock, Joseph E. Shigley, “Theory of Machines and Mechanisms”, 3rd Edition, Oxford University Press, 2003, ISBN 978-0195155983

3. R.L.Norton “Kinematics & Dynamics of Machinery”, Mc Graw Hill, 5th Edition, 2017, ISBN: 978-9351340201

4.Eric Constans, Karl B Dyer, “Introduction to Mechanism Design with computer applications”, CRC Press, 2nd Edition, 2019, ISBN: 978113874065-5

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**
	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	10
	SEE LAB TOTAL	**50**
	MAXIMUM MARKS FOR THE SEE	**150**

SEMESTER: II						
Course Code	:	**MMD323B1**	**Tribology for Mechanical Systems & Bearing Design**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*Program Specific Courses (Elective) (Group-B)*	SEE Duration	:	3 Hours

UNIT - I **9 Hours**

Introduction to Tribology: Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity.

Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's Poiseuille's theory, viscometers. Concept of lightly loaded bearings, Petroff's equation, Numerical problems

UNIT - II **9 Hours**

Hydrodynamic Lubrications: Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems.

Journal Bearings: Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Somerfield number and its significance, partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems

UNIT - III **8 Hours**

Hydrostatic Bearings: Hydrostatic thrust bearings, hydrostatic circular pad, annular pad, rectangular pad bearings, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems

Antifriction bearings: Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing mountings.

UNIT - IV **8 Hours**

Tribological properties of materials: Material selection for tribological applications, surface properties and treatments, coatings and surface modifications for improved performance

Nanotribology: Introduction, SFA Studies, AFM/FFM studies, Atomic-scale computer simulations

UNIT - V **8 Hours**

Tribological Testing and Measurement: Friction and wear measurements, Typical test geometries – sliding and wear tests – pin on disc, pin on flat; Abrasion Tests – Taber Abrasion test, Solid particle erosion test

Case Studies in Tribology: Analysis of real-world tribological failures; Case studies on bearing design and performance. Emerging technologies in tribology and bearing design; Smart materials and self-lubricating systems

Course Outcomes:

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

CO1	:	Understand the fundamental principles of tribology, including friction, wear, and lubrication, and their significance in engineering applications.
CO2	:	Apply design principles to create effective bearing solutions, considering load capacity, life estimation, and performance criteria.
CO3	:	Select appropriate materials and surface treatments for specific tribological applications based on their properties and performance criteria.
CO4	:	Design and conduct experiments to measure friction and wear, analyze the data, and evaluate real-world tribological problems, discuss emerging technologies in tribology

Reference Books
1. Basu S K, Sengupta S N, Ahuja B B, **"Fundamentals of tribology**" 7th Edition, 2015, ISBN-9788120327238, PHI Learning Private Limited, New Delhi
2. Bharat Bhushan, **"Introduction to Tribology"**, 2nd edition, 2013, ISBN 9781119944539 Wiley Publisher, New Jersey, USA
3. Prasanta Sahoo **"Engineering tribology"** 3rd edition, 2011 ISBN-9788120327245, PHI Learning Private Limited, New Delhi
4. K Lingaiah "Machine Design Data Hand book", 5th Edition, 2003, ISBN- 9780071367073, Mc Graw Hill India

Reference Books
1. Basu S K, Sengupta S N, Ahuja B B, **"Fundamentals of tribology**" 7th Edition, 2015, ISBN-9788120327238, PHI Learning Private Limited, New Delhi
2. Bharat Bhushan, **"Introduction to Tribology"**, 2nd edition, 2013, ISBN 9781119944539 Wiley Publisher, New Jersey, USA
3. Prasanta Sahoo **"Engineering tribology"** 3rd edition, 2011 ISBN-9788120327245, PHI Learning Private Limited, New Delhi
4. K Lingaiah "Machine Design Data Hand book", 5th Edition, 2003, ISBN- 9780071367073, Mc Graw Hill India

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	:	**MMD323B2**	**Experimental Methods in Stress Analysis**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*Program Specific Courses (Elective) (Group-B)*	SEE Duration	:	3 Hours

UNIT - I **9 Hours**

Introduction: Definition of terms, calibration, standards, dimensions and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning.

Data Acquisition and Processing: General data acquisition system, signal conditioning revisited, data transmission, Analog-to-Digital and Digital-to- Analog conversion, Basic components (storage and display) of data acquisition system. Computer program as a substitute for wired logic.

UNIT - II **9 Hours**

Strain Measurement - Strain, gage circuits, Potentiometer, Wheat Stone's bridges, Constant current circuits. Strain Analysis Methods-Two element and three element, rectangular and delta rosettes, Correction for transverse strains effects, stress gage - plane shear gage, Stress intensity factor gage.

Acoustic Emission and Ultrasonic Testing - Introduction to acoustic emission (AE) technique Principles of AE and its use in monitoring crack propagation Ultrasonic testing for stress and material property evaluation
Applications in structural health monitoring

UNIT - III **8 Hours**

Photoelastic Stress Analysis: Two-Dimensional Photo elasticity - Nature of light, - wave theory of light - optical interference - Polariscopes Stress-optic law- effect of stressed model in plane and circular Polariscopes. Reflection polariscope & its application

Isoclinic Iso chromatics fringe order determination – Fringe multiplication techniques - Calibration of Photoelastic model materials. Separation methods shear difference method, Analytical separation methods, Model to prototype scaling.

UNIT - IV **8 Hours**

Three-Dimensional Photo elasticity: Stress freezing method, General slice, Effective stresses, Stresses separation, Shear deference method, Oblique incidence method Secondary principals stresses, Scattered light photo elasticity, Principles, Polari scope and stress data analyses.

Coating Methods: Photoelastic Coating Method-Birefringence coating techniques Sensitivity Reinforcing and thickness effects - data reduction - Stress separation techniques Photoelastic strain gauges. Brittle Coatings Method: Brittle coating technique Principles data analysis - coating materials, Coating techniques.

UNIT - V **8 Hours**

Digital Image Correlation - Principles of DIC and its uses in experimental stress analysis, Equipment and setup for DIC, Methodology, Theory of deformation, Deformation analysis using digital image correlation, The challenges and Limitations of 2D-DIC.
Holography: Introduction, Equation for plane waves and spherical waves, Intensity, Coherence, Spherical radiator as an object (record process), Hurter, Driffeld curves, Reconstruction process, Holographic interferometry, Real-time and double exposure methods, Displacement measurement, Isopachics.

Course Outcomes: After going through this course the student will be able to:		
CO1	:	Understand experimental investigations to verify predictions by other methods.
CO2	:	Ability to acquire skills for experimental investigations
CO3	:	To provide a detailed knowledge of modern full field techniques such as Photoelastic Stress Analysis (PSA), Three-Dimensional Photo elasticity (TDP)
CO4	:	Explain different types of coatings, digital image correlation, test strain data using brittle coating and birefringent coating & holographic techniques

Reference Books

1. Experimental Methods for Engineers, Holman, 7th Edition, Tata McGraw-Hill Companies, Inc, New York, 2007
2. Mechanical measurements, R. S. Sirohi, H. C. Radha Krishna, New Age International Pvt. Ltd., New Delhi, 2004
3. Experimental Stress Analysis, Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra, Pant, Tata McGraw Hill, 1984, ISBN: 9780074519264
4. Experimental Stress Analysis, K Ramesh, Published by IIT Madras, ISBN:978-81-904235-6-4 (e-book)

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	:	**MMD323B3**	**Vehicle Dynamics & System Modelling**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*Program Specific Courses (Elective) (Group-B)*	SEE Duration	:	3 Hours

UNIT - I **9 Hours**

Introduction: Vehicle Dynamics terminology, The Driver-Vehicle-Ground System, Vehicle Fixed Coordinate System (SAE) and Earth Fixed Coordinate System; Mechanics Of Pneumatic Tires: Functions, Tire construction – Bias-ply Tire and Radial-ply, Tire Forces And Moments – Tire (Wheel) Axis System, Rolling Resistance of Tires, Tractive (Braking) Effort And Longitudinal Slip (Skid), Cornering Properties of Tires – Slip Angle and Cornering Force, Slip Angle and Aligning Torque, Camber and Camber Thrust.

Front Wheels Alignment: Need, Centre-Point Steering – Camber, King Pin Inclination, Negative Scrub Radius, Caster, Front-Wheel Toe-In or Toe-out. Performance Characteristics of Road Vehicles (two-axle vehicle): Equation of Motion and Maximum Tractive Effort – Front & Rear Wheel Drive (Numerical Problems).

UNIT - II **9 Hours**

Vehicle body Aerodynamics: Mechanics of Air Flow around a Vehicle, Pressure Distribution on a Vehicle, Aerodynamic Forces and moments, Factors influencing aerodynamic resistance coefficient (CD) and lift coefficient (CL) – Body shape, shape of the front and rear end, front and rear spoiler, angle of attack, ground clearance, load, operational factors.

Braking Performance: Braking Characteristics of a Two-Axle Vehicle – analysis of maximum braking force that the tire-ground contact can support, Loss of directional stability due to lock-up of rear tires, Quantitative determination of the conditions under which the front or the rear tires will lock first. (Numerical Problems); Antilock Brake Systems (ABS) and Traction Control Systems - prime functions

UNIT - III **8 Hours**

Handling Characteristics of Road Vehicles: Ackermann Steering Geometry, Error Curve of a Steering Linkage (No Numerical Problems); Steady-State Handling Characteristics of A Two Axle Vehicle: Simplified Steady-State Handling Model for a Two-Axle Vehicle. Neutral steer, Understeer, Oversteer. (Numerical Problems).

Steady-State Response to Steering Input: Yaw Velocity Response, Lateral Acceleration Response, Curvature Response (Numerical Problems); Testing of Handling Characteristics: Constant Radius Test, Constant Speed Test, Constant Steer Angle Test; Transient response characteristics; Directional Stability – Criteria for directional stability, Vehicle stability control.

UNIT - IV **8 Hours**

Vehicle Ride Dynamics: Human Response to Vibration - methods for assessing human tolerance to vibration; Two-Degree-of-Freedom Vehicle Model - Sprung and Un-sprung Mass (Quarter car model),

Aspects to evaluate the overall performance of a suspension system – Vibration isolation, suspension travel and road holding. Two-Degree-of-Freedom Vehicle Model - Pitch and Bounce (Numerical Problems); Concept of Active and Semi-Active Suspension Systems – Electrorheological Damper and Magnetorheological Damper.

UNIT - V **8 Hours**

Vehicle Rollover Analysis: Rollover scenario and importance, Rigid Vehicle Rollover Model – rigid vehicle model, Steady-state rollover on a flat road, Tilt table ratio, Side pull ratio; Suspended Vehicle Rollover model – Steady-state rollover model for a suspended vehicle, Contribution from the tire distribution and from the suspension distribution, Parameters influencing the suspended rollover model; Dynamic Rollover Model – Rigid dynamic model, Dynamic rollover model for a dependent and independent suspension vehicle;

Dynamic Rollover Threshold – Dynamic stability index, Rollover prevention energy reserve, rollover prevention metric, critical sliding velocity; Occupant in rollover, Sensing of rollover, Rollover safety control

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

CO1	:	Analyse the mechanics of pneumatic tyres, front wheel alignment, vehicle body aerodynamic and performance characteristics of the two axle road vehicles.
CO2	:	Analyse the braking performance and handling characteristics of road vehicles.
CO3	:	Analyse vehicle vibrations and apply to the vehicle suspension systems of the two axle road vehicles.
CO4	:	Analyse various vehicle rollover models for safety and rollover control.

Reference Books

1. J.Y. Wong "Theory of Ground Vehicles", 3rd Edition, John Willey and Sons, 2005, ISBN 978-8126565405.
2. Gang Sheng, Jian Pang, Mohamad S. Qatu, Rao V. Dukkipati, Zuo Shuguang, "Road Vehicle Dynamics", 1st Edition, SAE International, 2008, ISBN-10: 0768016436; ISBN-13:978-0768016437.
3. Rao V Dukkipati "Road Vehicle Accident Reconstruction", 1st Edition, New Age International Private Limited, ISBN-10: 8122434568; ISBN-13: 978-8122434569.

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	:	**MMD323B4**	**Reliability and Maintainability Engineering**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*Program Specific Courses (Elective) (Group-B)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**

Basic Probability Theory: Parameters and Reliability concepts, Rules for combining Probabilities of events, Failure Density and Distribution functions, Bernoulli's trials, Binomial distribution, Expected value and standard deviation for binomial distribution, Numericals Introduction to **Probability Distributions**: Normal, Poisson and Binomial distribution. Control Charts: Variable Chart – X Bar chart, R-chart and Sigma chart. Attribute Chart: P – Chart, nP Chart, C-Chart and U – Chart. Numerical.

UNIT - II	9 Hours

Network Reliability Evaluation: Basic concepts – Evaluation of network Reliability and Unreliability, Series systems, Parallel systems, Series - Parallel systems, partially redundant systems – Types of redundancies

Evaluation of network Reliability – Unreliability using conditional probability method – Paths based and cut-set based approach – complete event tree and reduced event tree methods. Numericals

UNIT - III	8 Hours

Failure Data Analysis: Introduction to Failure data analysis, Failure Data, Quantitative measures, MTTF, MTBF, Bathtub Curve, Mean Life, Life Testing, Problems, Introduction to Failure Mode and Effect Analysis. Numericals.

Reliability Improvement and Allocation: Difficulty in achieving reliability, Methods for improving reliability during design, Different techniques available to improve reliability, Optimization, Reliability-Cost trade off, Prediction and Analysis

UNIT - IV	8 Hours

Discrete Markov Chains & Continuous Markov Processes: Basic concepts, Stochastic transitional Probability matrix, time dependent probability evaluation, Limiting State Probability evaluation, Absorbing states, Markov Processes-Modelling concepts,

State space diagrams: time dependent reliability evaluation of single component repairable model, Evaluation of Limiting State Probabilities of TWO, two component repairable models – Frequency and duration concepts, Frequency balance approach. Numericals

UNIT - V	8 Hours

Maintainability and Maintenance Strategies - Definitions of Maintainability and its Importance Design for Maintainability, Maintenance strategies: Corrective, Preventive, Predictive Maintenance policies and their cost-effectiveness, Reliability-Centered Maintenance (RCM), Condition-Based Maintenance (CBM) Maintenance Optimization Techniques - Minimal Repair, Perfect Repair

Reliability and Maintainability Testing and Analysis - Testing methods for reliability and maintainability (Accelerated life testing, Field data collection), Analysis of test results, Reliability Growth Modelling, Life Cycle Cost (LCC) analysis, Application of Weibull analysis to failure data

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

CO1	:	Explain the concepts of reliability and probability theory.
CO2	:	Evaluate network Reliability and Unreliability for systems.
CO3	:	Analyze the various sampling and failure data analysis for reliability improvement
CO4	:	Evaluate the impact of maintenance strategies on system performance.

Reference Books
1. A K Govil, "Reliability Engineering", Prentice Hall – 2010, ISBN: 012535487-10
2. E. Balagurusamy "Reliability Engineering", Tata McGraw Hill, 2012, ISBN: 525-526-845-254
3.Roy Billinton and Ronald N. Allan, "Reliability Evaluation of Engineering Systems" B. S. Publications, 2013, ISBN(13):978-1489906878
4.Dimitri Kececioglu, "Maintainability, Availability, and Operational Readiness Engineering Handbook", Printice Hall Publisher, 1995, ISBN 9780135736272
5. Srinath L S, "Concepts in Reliability Engineering", East-West Press Private Limited, New Delhi, India. 2005, ISBN(13)-978-8176710480

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	:	**MMD324C1**	**Non-Linear Finite Element Methods**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*Professional Core Courses (Cluster Electives) (Group C)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Mathematical Preliminaries Set Notation, Function Notation, Vectors, Matrices, Tensors, Partial Differential Equations, Variational Calculus. Finite Element Basics. Weak Form of PDEs, Newton-Raphson Method. Derivatives of Implicit Functions, Step-Size Control, Convergence Criteria	
UNIT - II	**9 Hours**
Fundamental Terms of Geometric Nonlinearities, Theory of Second Order, Equilibrium in the Deformed System, Large Rotations I: Strain Measure, Large Rotations II: Co-rotational Formulation. Large Strain, General 1d-Relation to Strain, Green-Lagrange Strain, Logarithmic Strain. -Lagrange Formulation.	
UNIT - III	**8 Hours**
DYNAMIC PROBLEM Direct Formulation – Free, Transient and Forced Response – Solution Procedures –Eigen solution- Subspace Iterative Technique – Response analysis-Houbolt, Wilson, Newmark – Methods – Explicit & Implicit Methods- Lanczos, Reduced method for large size system equations.	
UNIT - IV	**8 Hours**
Fundamentals of Material Models, Representative One-Dimensional Basic Elements, Elasticity (Hooke-Element), Plasticity (St.-Venant-Element), Time-Dependent Behavior (Newton-Element), Models Composed of Basic Elements, Elasto-Plasticity (Prandtl-Element), Maxwell-Element for Creep, Kelvin-Voigt-Element for Visco-Elasticity, Classical Yield Conditions, Hardening Rules.	
UNIT - V	**8 Hours**
Contact Analysis: Introduction, Kinematics, Modelling Contact, Node-to-Node Contact, Node-to-Surface Contact, Point-to-Surface Contact, Surface-to-Surface Contact, Contact Kinematics, Direct Constraining, Penalty Method, Lagrange-Multiplier Method.	

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

CO1	:	Explain the fundamentals of Non-linear finite element methods
CO2	:	Develop the knowledge to analyze, structures under large deformations and material nonlinearity.
CO3	:	Selection of numerical techniques for solving engineering problems
CO4	:	Explore the use of finite element method knowledge to implement industrial project

Reference Books

1. Non-Linear Finite Element Analysis in Structural Mechanics, Wilhelm Rust, Springer, 2015, ISBN 978-3-319-13379-9

2. T.J.R. Hughes (2000), The Finite Element Method: Linear Static and Dynamic Finite Mechanics, Butterworth-Heinemann. Element Analysis, Dover Publications. ISBN(13)-978-0486411811

3. O. C. Zienkiewicz and R. L. Taylor (2000), The Finite Element Method: Volume 2 Solid Mechanics, Butterworth-Heinemann. ISBN: 0 7506 5055 9

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 a 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	:	**MMD324C2**	**Non-Destructive Evaluation**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*Professional Core Courses (Cluster Electives) (Group C)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**

Visual Inspection - Scope and advantages of NDA, Comparison of NDT with DT, classifications of NDT visual inspection equipment used for visual inspection – magnifying glass, magnifying mirror, Microscope, Borescope, Endoscope or Endo probes. Flexible fiber optic borescope, Video image scope

Eddy current Testing – Principle, Advantages, Disadvantages, Factor affecting Eddy current Response Material Conductivity, Permeability – Frequency – Geometry – Proximity (Lift off) – Typical Applications, Limitations, Types of Probes.

UNIT - II	**9 Hours**

Liquid Penetrant Testing – Introduction, Principle, Equipment, Procedures, Characteristics of Penetrants – Developers

Evaluation – Hazards, protection, advantages, limitations and applications

UNIT - III	**8 Hours**

Magnetic Particle Testing – Principle of magnetic particle testing – different methods to generate magnetic fields – Magnetic Particle testing equipment, Magnetic particle testing procedures method, De-magnetization, Magnetic Particle medium

Evaluation of indications and Acceptance standards – magnetic particle test, applications and limitations

UNIT - IV	**8 Hours**

Radiographic Testing – X-ray radiography, Principle, equipment & methodology – Type of industrial radiation sources and application. Radiographic exposure factors and technique – GAMA Ray and X-Ray equipment

Radiographic Procedure – Radiograph interpretation, Radiography Image quality indicators, radiographic techniques, film processing, methods of viewing radiographs, radiographic testing procedures for welds, precautions against radiation hazards.

UNIT - V	**8 Hours**

Ultrasonic Testing – Introduction, Principle of operation, type of ultrasonic propagation, ultrasonic probes, types of transducers, ultrasonic testing techniques. Method for evaluating discontinuities,

Laser Ultrasonics – Principle, uses laser-generated ultrasound waves to inspect materials without physical contact. This technique is ideal for thin materials, composite materials, and delicate structures. Advanced laser systems are used to scan large areas or complex geometries, providing detailed data on the material properties and integrity. Laser beams to measure vibrations on the surface of materials, which can help detect cracks, delaminations, and other defects.

Course Outcomes:

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

CO1	:	Understanding the principles and theory of NDT methods, as well as their scope and limitations
CO2	:	Differentiate various defect types and select the appropriate NDT methods for the specimen
CO3	:	Comprehend the radiographic testing, interpretation and evaluation.
CO4	:	Have a basic knowledge of ultrasonic testing which enables them to perform inspection of samples

Reference Books
1. J prasad, C G K Nair, "Non-Destructive Testing and Evaluation of Materials", Tata Mc Graw Hill Education Private Limited, 2nd Editon, 2017, ISBN 978-0070707030
2.American Metals Society "Non-Destructive Examination and Quality Control", Metals Hand Book, Vol 17, 19th Edition 1989, Metals Park, OHIO
3.Bray, Don E, Stanley and Roderic K, "Non-destructive Evaluation: A tool in design, manufacturing and service, CRC Press 1st edition, 1997 ISBN: 9781315272993
4. www.ndt.ed.org

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
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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	:	**MPD324C3**	**INTERACTIVE DESIGN FOR MANUFACTURING AND ASSEMBLY**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*Professional Core Courses (Cluster Electives) (Group C)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Introduction to Design for Manufacture & Assembly: Steps in DFMA, Advantages of DFMA, Limits, Fits and Tolerances, hole and shaft basis, Geometrical Dimensioning & Tolerances, Three datum – functional, machining and manufacturing, numericals	
UNIT - II	**9 Hours**
Design for Metal Casting – Compute the dimensions for Pattern, Mould, influence of parting line, cast holes, special sand cores, numericals, welding considerations, advantages of weldments over other concepts, design requirements and rules, case studies, Die casting alloys, machine selection, operation, sub-systems, optimum number of cavities, design principles	
UNIT - III	**8 Hours**
Design for Injection Moulding – Injection moulding systems – injection subsystem, machine sizing, materials for injection moulding and its properties, injection mould design – cavity and core, operation and cycle time, Design for powder metallurgy	
UNIT - IV	**8 Hours**
Electrical Connections and Wire Harness Assembly, classification of electrical interconnection, types of electrical Connections, types of Wires and Cables, preparation and assembly times, assembly and installation, analysis method	
UNIT - V	**8 Hours**
Design for High-Speed Automatic Assembly and Robot Assembly, Design of Parts for High-Speed Feeding and Orienting, Additional Feeding Difficulties, High-Speed Automatic Insertion, General Rules for Product Design for Automation, Design of Parts for Feeding and Orienting, product design for robot assembly.	

Course Outcomes:

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

CO1	:	Understand the basic manufacturing processes and electrical connections
CO2	:	Develop the assembly conditions and identify the datums
CO3	:	Design the parts for ease of pressure die casting, injection moulding and robot assembly
CO4	:	Formulate the DFMA work analysis sheet for various manufacturing processes

Reference Books

1. Product Design for Manufacture and Assembly, Geoffrey Boothroyd, Peter Dewhurst, Winston Knight Marcel Dekker, Inc., New york - Second Revision, ISBN O 8247-0584-X, 2013

2. Designing for Manufacturing, Harry Peck, Pitman Publications, 2nd edition, 2010, ISBN: 1-805233-810-5

3. Dimensioning and Tolerance for Quantity Production, Merhyle F Spotts, Englewood Cliffs, Prentice Hall, 5th edition, ISBN: 2-95433-956-6, 2012

4. Design for manufacturing – a structured approach, CorradoColig. BH publishers, 2012, ISBN: 2-95433-956-6

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	:	**MPD324C4**	**Integrated Chip Manufacturing**	CIE Marks	:	100
Credits L-T-P	:	3-1-0	*(Theory)*	SEE Marks	:	100
Hours	:	45L+45EL+30T	*Professional Core Courses (Cluster Electives) (Group C)*	SEE Duration	:	3 Hours

UNIT - I	**9 Hours**
Integrated Circuits: First transistor, integrated circuit, Moore's law, Feature and wafer size, Definition of the integrated circuit technology node. Overview of Integrated Circuits, Manufacturing materials, Processing equipment, Metrology tools, Circuit design, Mask formation, Wafer processing, Basic Structure of an Integrated Circuit Fabrication Facility	
UNIT - II	**9 Hours**
Wafer Fabrication: Introduction, Crystal Structures and Defects, Crystal orientation, Sand to Wafer, Crude silicon, Silicon purification, Crystal pulling, Czochralski method, Floating zone method, Wafering, Wafer finishing	
UNIT - III	**8 Hours**
Lithography: Introduction, Photoresist, Photolithography process, Wafer cleaning, preparation, Photoresist coating, Soft bake, Alignment and exposure, post exposure bake, Development, Hard bake, Metrology and defect inspection	
UNIT - IV	**8 Hours**
Semiconductor Packaging and testing: Introduction to Semiconductor Packaging: importance in Modern Electronics. Packaging Technologies: leaded and leadless packages, surface mount technology, and ball grid array, General flow of IC testing, Wafer test and IC package test, functional test, Build-in-self-test, Burn-in test	
UNIT - V	**8 Hours**
Cleanroom Technology, air conditioning and refrigeration equipment; air locks and air showers, floor systems, disinfection and sterilization; Performance Requirements for Clean-Room Garments, Filtration Mechanisms, Filter types	

Course Outcomes:

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

CO1	:	Explain the step-by-step sequence of processes used in creating various layers of a semiconductor chip.
CO2	:	Identify the environment requirements essential for high-quality semiconductor manufacturing.
CO3	:	Evaluate fabricated devices to assess desirable properties.
CO4	:	Apply principles of integrated circuit (IC) design and layout to develop simple electronic devices

Reference Books

1. Hong xiao, Introduction to Semiconductor manufacturing technology, second edition, Spie press ISBN: 9781510616530
2. Gary S. May Fundamentals of semiconductor manufacturing and process control, john wiley & sons, inc.publication, ISBN-13: 978-0-471-78406-7
3. dieter k. Schroder, Semiconductor material and device characterization, Third edition, , john wiley & sons, inc.publication,
4. James D. Plummer, Integrated Circuit Fabrication,, Cambridge university press, ISBN 978-1-009-30358-3

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)		
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Sl.No.	**COMPONENTS**	**MARKS**
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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**
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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, UWBRadars	
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 sensornetworks.	
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 navigationsystem.
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 (NPTEL)**	**CIE Marks**	:	**NA**
Credits L-T-P	:	**2-0-0**	***(Theory - NPTEL Online Course)***	**SEE Marks**	:	**100**
Hours	:	**60L**	***(Common Course to all M.Tech Programs)***	**SEE Duration**	:	**3 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.
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7. Exam is conducted by NPTEL.

SEMESTER: II						
Course Code	:	**MMD427DL**	**DESIGN THINKING LAB**	CIE Marks	:	50
Credits L-T-P	:	0-0-2	*(Design Thinking/Skill Lab)*	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 area identified for the M.Tech in Machine Design is as under:

Innovative Mechanism Design

Focuses on developing new mechanisms and systems that solve complex engineering problems. This includes the application of Design Thinking to create novel solutions for motion, force transmission, and energy conversion.

Structural Analysis and Optimization

Involves designing components with a focus on their strength, stability, and efficiency. This area incorporates material science and finite element analysis (FEA) for optimizing machine structures, considering stress, strain, and deformation under various loads.

Mechatronics Integration

Combines mechanical engineering with electronics and computer control systems to design intelligent machines. It emphasizes the interdisciplinary approach of Design Thinking for developing smart and automated systems.

Product Lifecycle and Sustainability

Focuses on designing machines that are energy-efficient, cost-effective, and sustainable throughout their lifecycle. This area integrates principles of sustainable design and eco- friendly materials, ensuring that machine designs minimize environmental impact.

Human-Machine Interaction (HMI) and Ergonomics

Centers on ensuring that machines are designed with the user in mind, optimizing ease of use, safety, and comfort. This includes designing intuitive interfaces, control systems, and physical components that align with human capabilities and behavior.

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 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: III						
Course Code	:	**MMD231TA**	**Fatigue & Fracture Mechanics**	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**

Introduction to Fatigue and Fracture: Industrial Significance of Fatigue, The Brittle Fracture Problem, Changes in Design Philosophy, Life-Limiting Factors.
Mechanical Behaviour: Tensile Properties, Resilience and Toughness, True Stress-Strain Curve, Stress Concentrations, Notched Tensile Test, Compression, Shear and Torsion., Stress-Strain Relationships, Combined Stresses, Yield Criteria, Residual Stresses

UNIT - II	**9 Hours**

Fracture Mechanics: Griffith's Theory of Brittle Fracture, Linear Elastic Fracture Mechanics, Elastic-Plastic Fracture Mechanics, Charpy and Izod Impact Testing, Drop-Weight Testing, Fracture Toughness Testing, Variables Affecting Fracture Toughness

UNIT - III	**8 Hours**

Fatigue of Metals: Stress Cycles, High-Cycle Fatigue, Low-Cycle Fatigue, Fatigue-Life Prediction, Cumulative Damage, Fatigue Crack Nucleation and Growth, Fracture Mechanics Approach to Fatigue Crack Propagation, Crack Closure, The Short Crack Problem, Geometrical Stress Concentrations, Manufacturing Stress Concentrations, Fatigue-Life Improvement, Fatigue Design Methodologies.

UNIT - IV	**8 Hours**

Fracture Control and Damage Tolerance Analysis: Principles of Fracture Control, Concepts of Damage Tolerance Analysis, Fracture Control Measures, Fracture Control Plans, Damage Tolerance Requirements, Fracture Mechanics and Fatigue Design.
Fatigue and Fracture of engineering alloys: Fracture Toughness of steels, Fatigue of Steels, Fracture Toughness of Aluminium Alloys, Fatigue of Aluminium Alloys, Fracture Toughness of Titanium Alloys. Fatigue of Titanium Alloys.

UNIT - V	**8 Hours**

Metallic Joints—Mechanically Fastened and Welded: Mechanically Fastened Joints, Threaded Fasteners in Tension, Bolts and Rivets in Bearing and Shear, Fatigue in Welded Joints, Methods for Improving the Fatigue Life of Welded Joints, Fracture Control in Welded Structures, Factors Affecting Fracture Toughness.

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

CO1	:	Identify and explain the material constants and their characteristic features at elastic and yielding conditions.
CO2	:	Develop a detailed behaviour of pre-existing crack and fracture constants using standard conditions.
CO3	:	Apply the conventional fatigue design and damage tolerant design for life estimation.
CO4	:	Develop a fracture control and enhance the fatigue life for different materials under structural loads

Reference Books
1. F.C. Campbell, "Fatigue and Fracture: Understanding the Basics", 2011. ISBN: 978-1-61503-976-0
2. H.P. Rossmanith, "Teaching and Education in Fatigue and Fracture", Istli Special Publication. 1996. ISBN: 9780419207009, 0419207007, 0203476042, 9780203476048, 978020323736
3. Robert L. Norton "Machine Design", Pearson Education India, 2000, ISBN 0-06-008493-3
4. S.Suresh, Fatigue of Materials, Cambridge University Press, -1998, ISBN 978-1316509937
5.T.L.Anderson, Fracture Mechanics – Fundamentals and Applications, 4th Edition, CRC Press, ISBN 9781498728140, 2017

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (CIE-Theory)		
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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	:	**MMD332E1**	**DESIGN PRACTICE – I**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16L	*Professional Elective Course (NPTEL) (Group – E)*	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 Design/Product design
Week 2: Stanford model of Design thinking/ Stages of engineering design of products / Introduction to Concurrent engineering
Week 3: Concurrent engineering Approaches: Benefits, influencing factors
Week 4: Product Development Methodology: Concurrent engineering in Practice
Week 5: Product embodiment design (robustness of design/Average Quality loss)
Week 6: Material selection process in design
Week 7: House of quality, Specifications (Fits and Tolerances), Axiomatic Design
Week 8: Introduction to Group Technology, Creating forms and shapes, Introduction to electronics

Reference Books

1. Nanua Singh, "Systems approach to computer integrated design and manufacturing", Wiley India Pvt. Ltd., 4435-36/7, Ansari Road, Daryaganj, New Delhi-110002.
2. Karl T. Ulrich, Steven. D. Eppinger, "Product design and development", McGraw hill publications.

GENERAL GUIDELINES

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11. Exam is conducted by NPTEL

SEMESTER: III						
Course Code	:	**MMD332E2**	**Design for Mechanical Transmission System**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16L	*Professional Elective Course (NPTEL) (Group – E)*	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: Course Introduction, Evaluation, and application of Gearbox, GP, Step Ratio, Preferred Numbers, Structural Formula & Rules of optimum Gearbox, Ray diagram construction.
Week 2: Machine Tool Gearbox - Kinematic diagram construction, Centre distance and teeth calculation, Problem solving.
Week 3: Automobile Gearbox - General engine operation and transmission types, Saw tooth diagram and design procedure for gearbox, Problem solving, tyre specification.
Week 4: Basic transmission types and kinematic diagram, Gear failures and material selection, module calculation concept – part I.
Week 5: Module calculation concept – part II, shaft design, lubrication selection and method, bearing selection and gearbox losses.
Week 6: Brake - Introduction, working principle and types, Torque requirement for drum brake systems, Problem solving.
Week 7: Torque requirement for disc brake systems, static and dynamic analysis, dynamic analysis – brake force distribution and optimum
Week 8: Problem solving, Braking efficiency & distance and brake factor, Problem solving and friction materials.

Reference Books

1. P.H. Joshi (2007), Machine Tools Handbook – Design and Operation, Tata McGraw Hill, New Delhi
2. N. K. Mehta (2010), Machine Tool Design and Numerical Control, McGraw Hill, New Delhi.
3. G. Lechner and H. Naunheimer (1999), Automotive Transmissions: Fundamentals, Selection, Design and Application, Springer, Berlin.
4. Peter Lynwander (1983), Gear Drive Systems : Design and Application, Marcel Dekker Inc, New York.

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7. Exam is conducted by NPTEL

SEMESTER: III						
Course Code	:	**MMD332E3**	**Dynamic Behaviour of Materials**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16L	*Professional Elective Course (NPTEL) (Group – E)*	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: dynamic deformation and failure
Week 2: Introduction to waves: elastic waves; types of elastic waves; reflection, refraction and interaction of waves
Week 3: Plastic waves and shock waves: Plastic waves of uniaxial stress, uniaxial strain and combined stress; Taylor's experiments; shock waves
Week 4: Shock wave induced phase transformation; Explosive-material interaction and detonation
Week 5: Experimental techniques for dynamic deformation: intermediate strain rate tests; split Hopkinson pressure bar; expanding ring test; gun systems
Week 6: Review of mechanical behavior of materials (especially metals): Elastic and plastic deformation of metals; dislocation mechanics.
Week 7: Plastic deformation of metals at high strain rates: Empirical constitutive equations; relationship between dislocation velocity and applied stress; physically based constitute equations
Week 8: Plastic deformation in shock waves: Strengthening due to shock wave propagation; dislocation generation; point defect generation and deformation twinning

Reference Books

1. L.B. Freund, Dynamic Fracture Mechanics, Cambridge, 1990
2. Y. Bai B. Dodd, Adiabatic Shear Localization, Pergamon, Oxford, UK, 1992
3. G.E. Dieter, Mechanical Metallurgy, Mc Graw Hill, 1986
4. J.W. Swegle, D.E. Grady, in Shock Waves in Condensed Matter- 1985

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7. Exam is conducted by NPTEL

SEMESTER: III						
Course Code	:	**MMD332E4**	**Experimental Modal Analysis**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16L	*Professional Elective Course (NPTEL) (Group – E)*	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, need and applications of EMA, lumped parameter models, Analytical modal analysis of SDOF undamped and damped systems; Free and forced response, FRF

Week 2: Analytical modal analysis of undamped and damped MDOF systems; eigenvalue problem (EVP), free response, Forced response, FRF matrix, modal space, modal response

Week 3: IRF, Convolution integral, FRF characteristics, FRF types, FRF Plots, stiffness and mass lines; modal contributions; antiresonances

Week 4: Signal processing for experimental modal analysis, Fourier series, Fourier transform, Discrete Fourier Series, Discrete Fourier transform

Week 5: Time sampling; aliasing, sampling theorem, quantization, windowing; window functions, random signals, correlation, spectral density, white noise

Week 6: FRF measurement with an impact hammer, FRF estimation, Impact hammer, response measurement, accelerometer, mounting and selection, LDV

Week 7: Auto and cross spectrums, H1- H2 estimates, spectrum averaging, coherence function, FRF measurement simulation, boundary conditions, calibration

Week 8: FRF measurement with shaker, electromagnetic shaker, shaker-structure interaction, force transducer, impedance head; FRF measurement simulation, pseudo-random, periodic random, burst random, chirp excitation

Reference books

1) Ewins, D.J., Modal Testing: Theory, Practice and Application, 2000, Research studies press, England
2) Modak, S.V., Analytical and Experimental Modal Analysis, 2023, CRC Press, Taylor & Francis Group (Under publication)

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7. Exam is conducted by NPTEL

SEMESTER: III							
Course Code	:	**MMD433P**	**MINOR PROJECT**	**CIE Marks**	:	**50**
Credits L-T-P	:	**0-0-6**		**SEE Marks**	:	**50**
Hours/Week	:	**12**		**SEE Duration**	:	**3 Hours**

Guidelines

1. Students can form groups 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 on 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	:	**MMD434N**	**Industry Internship/Research Internship/ Projects in CoEs**	**CIE Marks**	:	**50**
Credits L-T-P	:	**0-0-6**		**SEE Marks**	:	**50**
Hours/Week	:	**12**		**SEE Duration**	:	**3 Hours**
Faculty Coordinator:						

Guidelines

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	**20%**

SEMESTER: IV						
Course Code	:	**MMD441F1**	**Design Practice II**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16L	*Program Specific Courses (NPTEL -Elective) (Group F)*	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: Geometrical Transformations
Week 2: 3-D shapes/ solid modelling
Week 3: Micro-electro Mechanical Systems (MEMS)/ Sensors and actuators
Week 4: Rapid Prototyping (3-D printing)/ Rapid tooling
Week 5: Creating forms and their geometric transformation models
Week 6: Strength and Stiffness of Structural Elements/ Mechanisms
Week 7: Mechatronics/ Introduction to Control
Week 8: Intelligent Product Design

Reference Books

1. Nanua Singh, "Systems approach to computer integrated design and manufacturing", Wiley India Pvt. Ltd., 4435-36/7, Ansari Road, Daryaganj, New Delhi-110002.
2. Karl T. Ulrich, Steven. D. Eppinger, "Product design and development", McGraw hill publications.

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	:	**MMD441F2**	**Fundamentals of Artificial Intelligence**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16 L	*Program Specific Courses (NPTEL -Elective) (Group F)*	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: AI and Problem Solving by Search
Week 2: Problem Solving by Search
Week 3: Problem Solving by Search
Week 4: Knowledge Representation and Reasoning
Week 5: Reasoning under Uncertainty
Week 6: Planning and Decision Making
Week 7: Machine Learning
Week 8: Machine Learning

Reference Books

1. Patrick Henry Winston, Artificial Intelligence, Third Edition, Addison-Wesley Publishing Company, 2004.
2. Nils J Nilsson, Principles of Artificial Intelligence, Illustrated Reprint Edition, Springer Heidelberg, 2014.
3. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, PHI 2009.
4. Nils J. Nilsson, Quest for Artificial Intelligence, First Edition, Cambridge University Press, 2010.

GENERAL GUIDELINES

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7. Exam is conducted by NPTEL.

SEMESTER: IV						
Course Code	:	**MMD441F3**	**Heat Exchangers – Fundamentals & Design Analysis**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16 L	*Program Specific Courses (NPTEL -Elective) (Group F)*	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: Background, Application, Classification, Common terminologies
Week 2: Introduction to Thermal and hydraulic aspects, pressure drop and heat transfer, sizing and rating. F-LMTD and -NTU method.
Week 3: Tubular Heat Exchangers: different designs, brief description of Shell and Tube Heat Exchangers, Special types
Week 4: Compact heat exchangers, enhancement of heat transfer, extended surface or Fin, fundamental of extended surface heat transfer, Fin tube heat exchanger
Week 5: Plate Fin Heat Exchangers (PFHE), types, construction, fabrication, design, application. Multistream PFHE.
Week 6: Multistream PFHE continued. Direct contact heat exchangers, types, application, simple analysis.
Week 7: Regenerators, types of regenerators, construction, application. Theory of Regenerator, -NTU and - method.
Week 8: Heat pipes, construction, working principle, application, analysis. Special heat pipes

Reference Books

1) Fundamentals of Heat Exchanger Design by R. K. Shah, Dusan P. Sekulic, John Wiley & Sons, 11-Aug-2003.
(2) Heat Exchanger Design Handbook by Kuppan Thulukkanam, Taylor & Francis, 23-Feb-2000.
(3) Heat Exchangers: Selection, Rating, and Thermal Design, Third Edition by Sadik Kakac, Hongtan Liu, CRC-Press, 01-Feb-1998.
(4) Cryogenic Heat Transfer, Second Edition by Randall F. Barron, Gregory F. Nellis, CRC Press, May 23, 2016.

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.
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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	:	**MMD441F4**	**Machinery Fault Diagnosis and Signal Processing**	CIE Marks	:	NA
Credits L-T-P	:	2-0-0	*(Theory - NPTEL Course online)*	SEE Marks	:	50
Hours	:	16 L	*Program Specific Courses (NPTEL -Elective) (Group F)*	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, Maintenance Principles, FMECA, Fault Diagnostics and Prognostics
Week 2: Basics of vibration, Free and Forced Response, Vibration and Shock Isolation, Rotor dynamics, Practical examples of vibration
Week 3: Time Domain Analysis, Frequency Domain Analysis, Non-stationary signal analysis, Modulation and Beats, Orbit and Order Analysis
Week 4: Computer Aided Data Acquisition, Data Recording, Cepstrum Analysis, Hilbert Transform in Condition Monitoring
Week 5: Introduction to MATLAB, Numericals in Signal Processing and Data Acquisition, Signal Hetrodyning, Practical Signals
Week 6:Basics of Instrumentation, Signal Conditioning and Filtering, Errors in Measurements, dynamic range and frequency response
Week 7: Accelerometers, Vibration Monitoring, Rotational Speed Measurements, Basics of Noise, Noise Monitoring
Week 8: Introduction to Faults in Rotating Machines, Unbalance Detection, Field Balancing, Misalignment, Crack and Looseness

Course duration: 8 Weeks
Course start Date: Jan 20,2025
Course end date: March 14,2025
Probable Exam date: March 22,2025
Course Instructors:

GENERAL GUIDELINES

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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.
8. https://archive.nptel.ac.in/courses/112/105/112105232/

SEMESTER: IV						
Course Code	:	**MMD442P**	**MAJOR PROJECT**	**CIE Marks**	:	**100**
Credits L-T-P	:	**0-0-18**		**SEE Marks**	:	**100**
Hours/Week	:	**36**		**SEE Duration**	:	**3 Hours**
Faculty Coordinator:						

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%

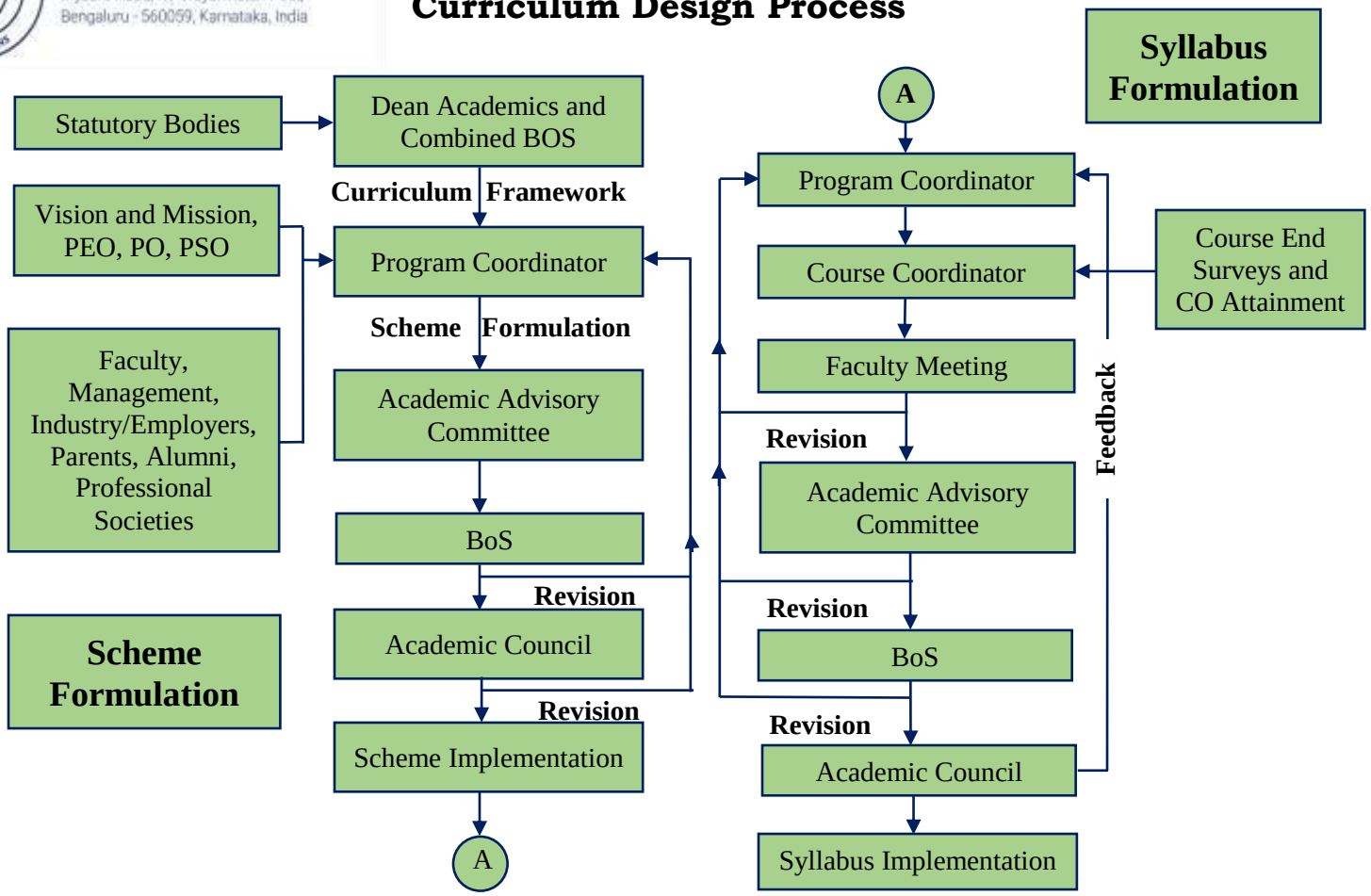
Scheme for Semester End Evaluation (SEE):
Major Project SEE evaluation shall be conducted in two stages. This is initiated after fulfilment of submission of Project Report and CIE marks.
Stage-1 Report Evaluation: Evaluation of Project Report shall be done by the Guide and an External examiner.
Stage-2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

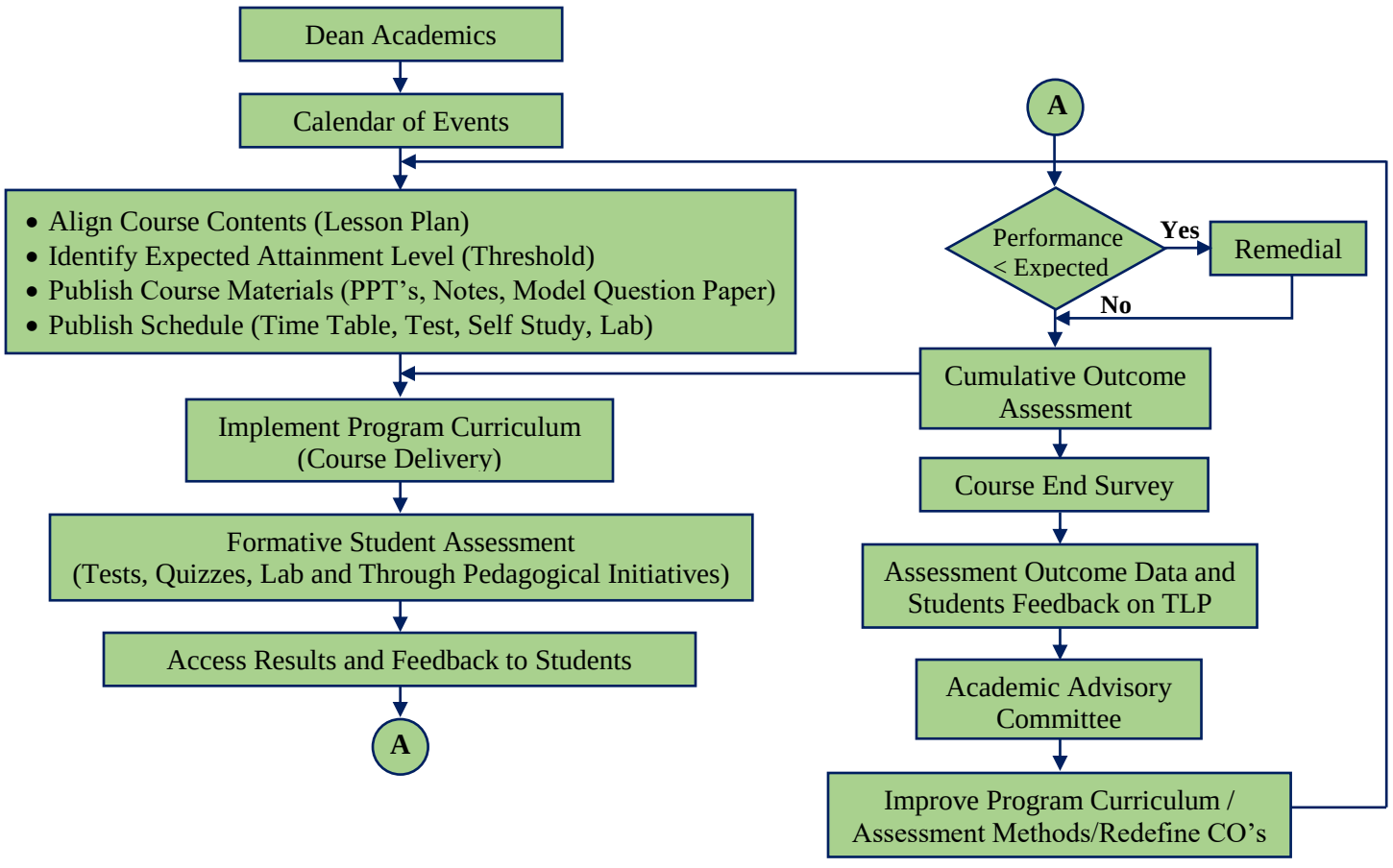
SEE procedure is as follows:

Report Evaluation	Internal Examiner: 100 Marks **(A)** External Examiner: 100 Marks **(B)**	**Report Evaluation (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**

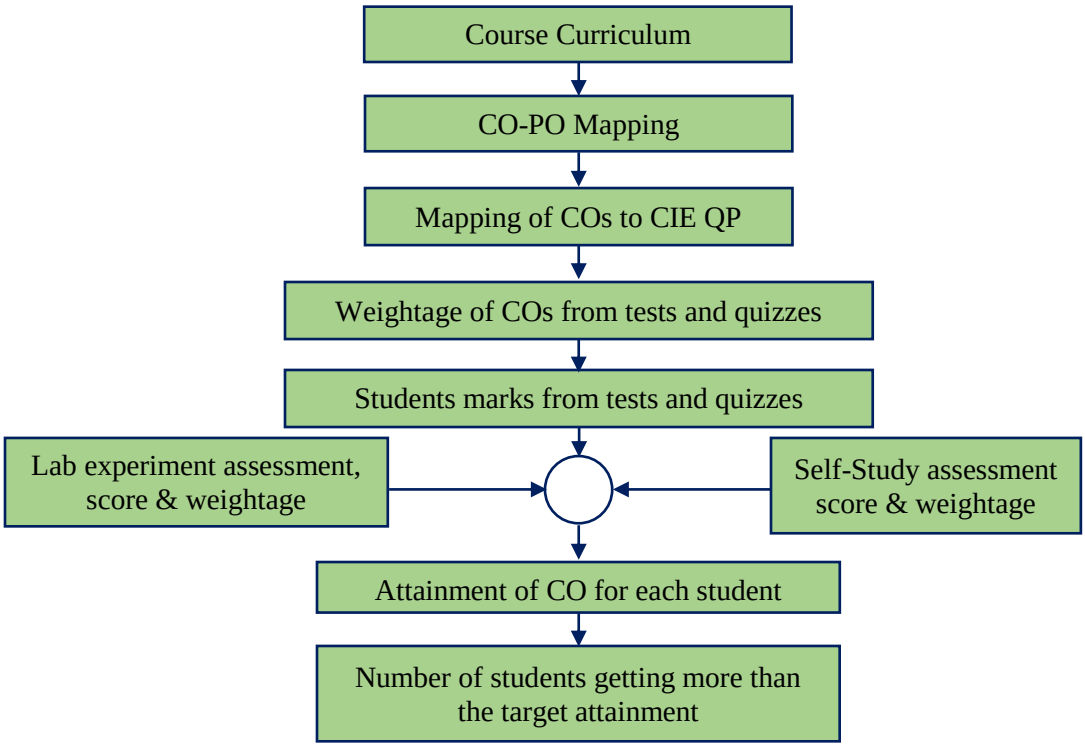
Curriculum Design Process



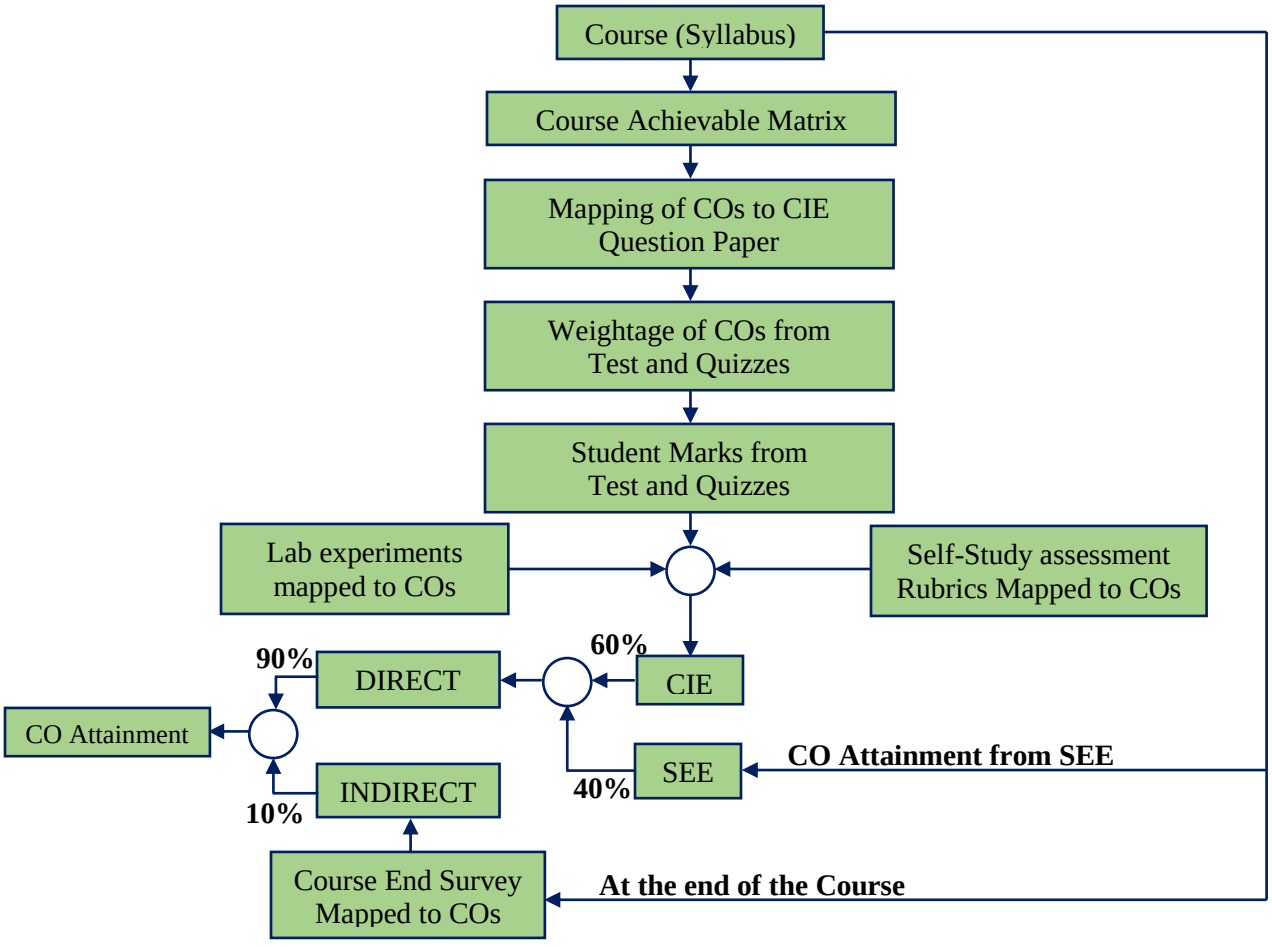
Academic Planning and Implementation



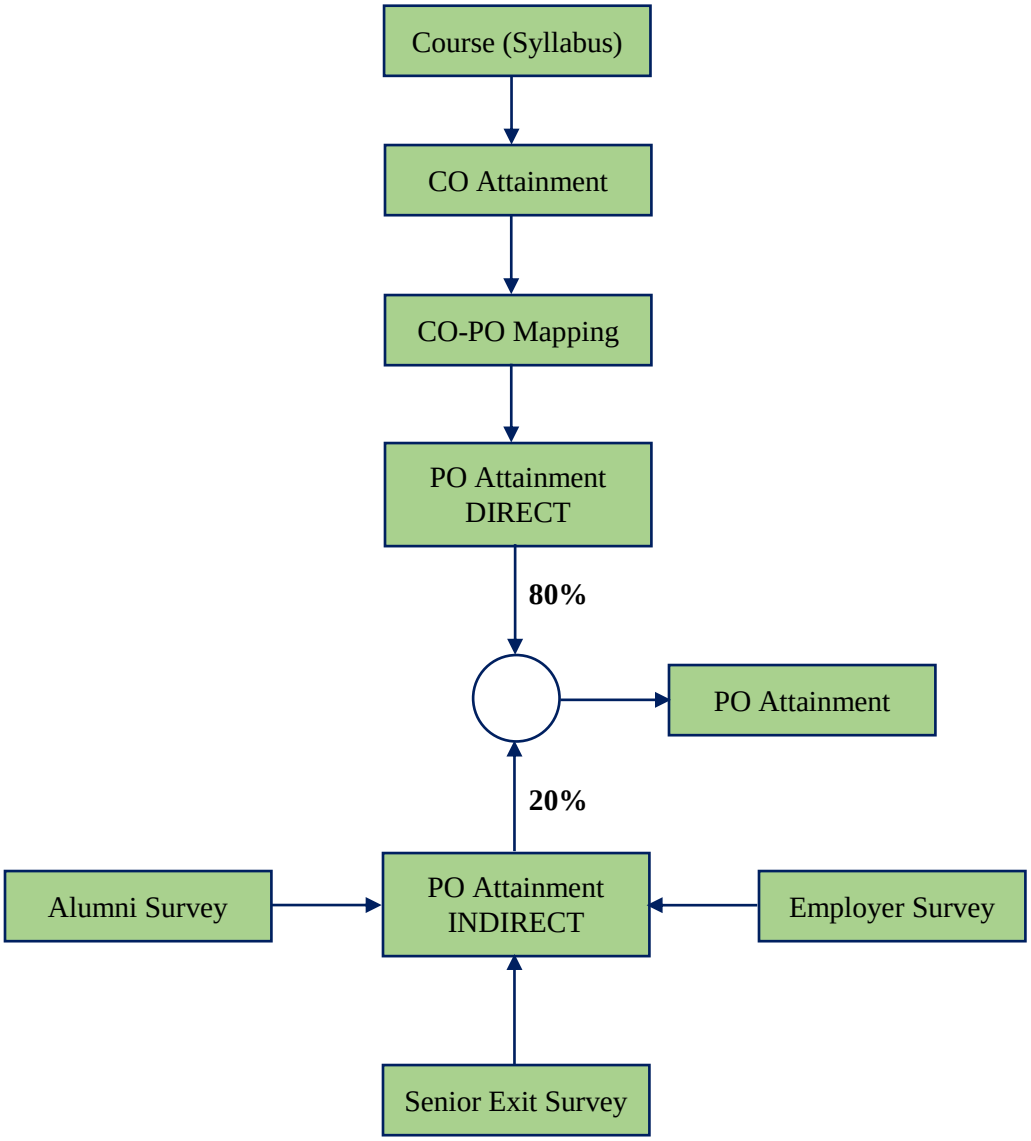
Process For Course Outcome Attainment



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.

INNOVATIVE TEAMS OF RVCE

Ashwa Mobility Foundation (AMF): Designs and fabricates Formula-themed race cars and mobility solutions to address urban transportation issues.

Astra Robotics Team: Focuses on designing and building application-specific robots.

Coding Club: Helps students gain coding skills and succeed in competitions like GSoC and ACM-ICPC.

Entrepreneurship Development Cell (E-Cell): Promotes entrepreneurship through workshops, speaker sessions, and mentoring for startups.

Frequency Club Team: Works on software and hardware, emphasizing AI and Machine Learning.

Team Garuda: Develops a supermileage urban concept electric car and E-mobility products.

Team Jatayu: Builds low-cost UAVs with autonomous capabilities for various tasks.

Solar Car Team: Aims to create a solar electric vehicle for sustainable transportation.

Team Antariksh: Focuses on space technology and the development of operational rockets.

Team Chimera: Builds a Formula Electric Car through R&D in E-Mobility.

Helios Racing Team: Designs and tests All-Terrain Vehicles, participating in SAE's BAJA competitions.

Team Hydra: Develops autonomous underwater vehicles for tasks like water purification.

Team Krushi: Creates low-cost farming equipment to assist farmers in cultivation and harvesting.

Team Vyoma: Designs and tests radio-controlled aircraft and UAVs.

Team Dhruva: Engages in astronomy-related activities and collaborates on projects with organizations like ICTS and IIA.

Ham Club: Promotes Amateur Radio and explores technical innovations in communications, especially for disaster response.

Cultural Activity Teams

1. AALAP (Music club)
2. DEBSOC (Debating society)
3. CARV (Dramatics club)
4. FOOTPRINTS (Dance club)
5. QUIZCORP (Quizzing society)
6. ROTARACT (Social welfare club)
7. RAAG (Youth club)
8. EVOKE (Fashion team)
9. f/6.3 (Photography club)
10. CARV ACCESS (Film-making

NSS of RVCE

NCC of RVCE

VISION

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

MISSION

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

QUALITY POLICY

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

CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation