Scheme and Syllabus of I & II Semesters

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)

in

MACHINE DESIGN

DEPARTMENT OF

MECHANICAL ENGINEERING

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MECHANICAL ENGINEERING

Scheme and Syllabus of I & II Semesters

(Autonomous System of 2023 Scheme)

Master of Technology (M.Tech)

in

MACHINE DESIGN

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

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

Program Outcomes (PO)

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

PO1: An ability to independently carry out a 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

DR. AMBEDKAR INSTITUTE OF TECHNOLOGY

(Autonomous Institute Affiliated To VTU)

Accredited by NAAC with 'A' grade)

Dept. of Mechanical Engineering,

Scheme of Teaching and Examination First Semester 2022-2023

M. Tech in Machine Design

FIRST SEMESTER

Sl. No.	Course	Course Code	Course/Subject Title	Teaching hours per week			Maximum Marksallotted				Examination Credits
				Lecture	Practical / Project/ Seminar	Tutorial/ Skill Development Activity T/SDA	Duration in hours	CIE	SEE	Total	
1	BSC	22MMD11	Mathematical Methods in Engineering	03	00	00	03	50	50	100	3
2	IPCC	22MDE12	Signal analysis and condition monitoring	03	02	00	03	50	50	100	4
3	PCC	22UMD13	Advanced theory of vibrations	03	00	02	03	50	50	100	4
4	PCC	22MMD14	Advanced Mechanism design	02	00	02	03	50	50	100	3
5	PCC	22MMD15	Advanced Mechanics of Solids	02	00	02	03	50	50	100	3
6	MCC	22RMI16	Research Methodology and IPR	03	00	00	03	50	50	100	3
7	PCCL	22MMDL17	Numerical Simulations Laboratory	01	02	00	03	50	50	100	2
8	22AUD 18/ 22AEC	BoS recommended ONLINE	AUD/AEC	Classes and evaluation procedures are as per the policy of the online course providers.							PP

	18	courses									
			Total	**17**	**04**	**06**	**21**	**350**	**350**	**700**	**22**

Note: BSC-Basic Science Courses, PCC: Professional core. IPCC-Integrated Professional Core Courses, MCC- Mandatory Credit Course, AUD/AEC –Audit Course / Ability Enhancement Course(A pass in AUD/AEC is mandatory for the award of the degree), PCCL-Professional Core Course lab, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities**(Hours are for Interaction between faculty and students)

Integrated Professional Core Course (IPCC): **Integrated Professional Core Course (IPCC)**: Refers to Professional Theory Core Course Integrated with practical of the same course. The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

Audit Courses /Ability Enhancement Courses Suggested by BoS (ONLINE courses): Audit Courses: These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs.

Ability Enhancement Courses:

● These courses are prescribed to help students to enhance their skills in in fields connected to the field of specialisation as well allied fields that leads to employable skills. Involving in learning such courses is impetus to lifelong learning.

● The courses under this category are online courses published in advance and approved by the concerned Board of Studies.

● Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.

● In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.

● The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

Skill development activities: Under Skill development activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).

2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.

3. Involve in case studies and field visits/ fieldwork.

4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.

5. Handle advanced instruments to enhance technical talent.

6. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.

7. Work on different software/s (tools) to simulate, analyse and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities

which will enhance their skill. The prepared report shall be evaluated for CIE marks.

Scheme of Teaching and Examination Second Semester 2022-2023
M.Tech in Machine Design

SECOND SEMESTER

Sl. No.	Course	Course Code	Course/Subject Title	Teaching hours per week				Maximum Marksallotted			Examination Credits
				Lecture	Practical / Project/ Seminar	Tutorial/ Skill Development Activity	Duration in hours	CIE	SEE	Total	
1	PCC	22MMD21	Advanced Machine Design	02	00	02	3	50	50	100	03
2	IPCC	22MMD22	Advanced Finite Element Methods & Applications	3	2	00	3	50	50	100	04
3	PEC	22MMD23x	Professional Elective 1	02	00	02	03	50	50	100	3
4	PEC	22MMD24x	Professional Elective 2	02	00	02	03	50	50	100	3
5	MPS	22MMD25	Mini Project with Seminar	00	04	02	--	100	--	100	3
6	PCCL	22MMDL26	Finite Element Methods Laboratory	01	02	00	03	50	50	100	02
7	AUD/AEC	22AUD27	Suggested ONLINE courses	Classes and evaluation procedures are as per the policy of the online course providers.							PP
TOTAL				**10**	**08**	**08**	**15**	**350**	**250**	**600**	**18**

Note: PCC: Professional core courses, PEC: Professional Elective Courses, IPCC-Integrated Professional Core Courses. MPS-Mini Project With Seminar; AUD/AEC; Audit Courses / Ability Enhancement Courses (Mandatory), PCCL-Professional Core Course lab, L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities(Hours are for Interaction between faculty and students)

10											

PROFESSIONAL ELECTIVE-1

PROFESSIONAL ELECTIVE-2

Sl. No	Subject Code	Subject title		Sl. No	Subject Code	Subject title
1	23MMD231	OPTIMIZATION TECHNIQUES		1	23MMD241	PRODUCT DESIGN FOR QUALITY
2	23MMD232	DESIGN OF EXPERIMENTS		2	23MMD242	MECHATRONICS SYSTEMS DESIGN
3	23MMD233	FATIGUE AND FAILURE ANALYSIS		3	23MMD243	DESIGN FOR MANUFACTURE AND ASSEMBLY

Note:

1 Mini Project with Seminar: This may be hands-on practice**,** survey report, data collection and analysis, coding, mobile app development, field visit and report preparation, modelling of system, simulation, analysing and authenticating, case studies, etc.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Students can present the seminar based on the completed mini-project. Participation in the seminar by all postgraduate students of the program shall be mandatory.

The CIE marks awarded for Mini-Project work and Seminar shall be based on the evaluation of Mini Project work and Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25. Mini-Project with Seminar shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the Mini Project and Seminar shall be declared as fail in that course and have to complete the same during the subsequent semester. There is no SEE for this course.

2. Internship: All the students shall have to undergo a mandatory internship of **06 weeks** during the vacation of II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. The internship shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in the internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Scheme of Teaching and Examination Third Semester 2022-2023
M. Tech in Machine Design

THIRD SEMESTER

Sl. No.	Course	Sub Code	Subject Title	Teaching hours per week			Maximum Marks allotted			Examination Credits
				Lecture	Practical / Project/ Seminar	Tutorial/ Skill Development Activity	CIE	SEE	Total	
1	PCC	22MMD31	Fracture Mechanics	3	-	2	50	50	100	**4**
2	PEC	22MMD32X	Professional Elective 3	3	-	-	50	50	100	**3**
3	OEC	22MMD33X	Open Elective Course – 1	3	-	-	50	50	100	**3**
4	PROJ	22MMDP34	Project work Phase-1	-	6	-	100	-	100	**3**
5	SP	22MMDS35	Societal Project	-	6	-	100	-	100	**3**
6	INT	22MMDI26	Internship	6 Weeks internship to be completed during the interveningvacation of II & III Semester)						**6**
7	**Total**			**09**	**12**	**02**	**400**	**200**	**600**	**22**

Note: **PCC**: Professional core courses, **PEC**: Professional Elective Courses, **IPCC**-Integrated Professional Core Courses. **MPS**-Mini Project With Seminar; **AUD/AEC**; Audit Courses / Ability Enhancement Courses (Mandatory), **PCCL**-Professional Core Course lab, **L**-Lecture, **P**-Practical, **T/SDA**-Tutorial / Skill Development Activities (Hours are for Interaction between faculty and students)

PROFESSIONAL ELECTIVE-3

Sl. No	Subject Code	Subject title
1	22MMD321	Composite structures
2	22MMD322	Theory of Plasticity
3	22MMD323	Design of aerospace structures
4	22MMD324	Introduction to robotics
5	22MMD325	Sustainability engineering

OPEN ELECTIVE-I

Sl. No	Subject Code	Subject title
1	22MMD331	Design automation with IoT
2	22MMD332	Reverse Engineering
3	22MMD333	Optimization through MATLA
4	22MMD334	Introduction to Hybrid and Electric Vehicles
5	22MMD335	3D Printing

Note:

1. Project Work Phase-1: The project work shall be carried out individually. However, in case a disciplinary or interdisciplinary project requires more participants, then a group consisting of not more than three shall be permitted. Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall pursue a literature survey and complete the preliminary requirements of the selected Project work. Each student shall prepare a relevant introductory project document, and present a seminar. CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

2. Societal Project: Students in consultation with the internal guide as well as with external guide (much preferable) shall involve in applying technology to workout/proposing viable solutions for societal problems. CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25. Those, who have not pursued

/completed the Societal Project, shall be declared as fail in the course and have to complete the same during subsequent semester/s after satisfying the Societal Project requirements. There is no SEE (University examination) for this course.

Internship: Those, who have not pursued /completed the internship, shall be declared as fail in the internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms. CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

Scheme of Teaching and Examination Forth Semester 2022-2023
M. Tech in Machine Design

FOURTH SEMESTER

Sl. No.	Course	Sub Code	Subject Title	Teaching hours per week			Maximum Marks allotted			Examination Credits
				Lecture	Practical / Project/ Seminar	Tutorial/ Skill Development Activity	CIE	SEE	Total	
1	Project	22MMDP41	Project work Phase - 2	-	8	-	100	100	200	**18**
Total				**-**	**08**	**-**	**100**	**100**	**200**	**18**
Grand Total (I to IV Semester) :				**2100 Marks ; 80 Credits**						

Note:

1. Project Work Phase-2:

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall continue to work of Project Work phase -1to complete the Project work. Each student / batch of students shall prepare project document, and present a seminar. CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25. SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

Total Credits 22+18+22+18 =80

Program Outcomes (POs)

1. **PO1:** An ability to independently carry out research /investigation and development work to solve practical problems.

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

3. **PO3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.

4. **PO4**: Students should be able to design, synthesize and analyse a physical engineering systems using modern tools and techniques.

5. **PO5**: Students should be able to conduct analytical and experimental investigations on Industrial and societal problems to provide sustainable solutions

Course Title	**MATHEMATICAL METHODS IN ENGINEERING**		
Course Code	**22MMD11**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

COURSE OBJECTIVE:

This course will enable students to

1. Know how to Model and Solve, Ordinary Differential Equations of First andSecond Order.
2. Understand Linear Algebra and its Applications.
3. Apply the Calculus of Variation for Engineering Applications
4. Use the Methods of Complex Analysis for Engineering

UNIT I **Modelling with First Order Differential Equations:** Introduction, Differential Equations as a Mathematical Model, Fundamentals of Differential Equations, Variables separable, Motion of a Falling Body (Falling Bodies and Air Resistance), Newton's law of cooling, Heat flows in Solids by conduction and Heat Transfer in Solids Submerged in Fluid. **Second-Order Linear ODEs:** Homogeneous Linear ODEs with Constant Coefficients, Modeling of Free Oscillations of a Mass–Spring System, Non-homogeneous ODEs, Modeling: Forced Oscillations.	**9 hours**
Teaching Learning Process :Power-point Presentation, Video demonstration or Simulations, Chalk andTalk are used for Problem Solving	
UNIT II **Partial Differential Equations:** Basic Concepts of PDEs, Modeling: Vibrating String (Wave Equation), Solution by Separating Variables, D'Alembert's Solution of the Wave Equation and Characteristics, Modeling: Heat Flow from a Body in Space (Heat Equation), HeatEquation: Solution by Fourier Series.	**9 hours**
Teaching Learning Process: Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving.	
UNIT III **Linear Algebra:** Matrices, Vectors, Matrix Multiplication, Linear Independence. Vector Space, Rank of a Matrix. Solutions of Linear Systems: Gauss Elimination and Gauss–Jordan Methods, Some Applications of Eigenvalue and Eigenvectors problems by Rayleigh power method	**7 hours**
Teaching Learning Process : Power-point Presentation, Video demonstration or Simulations, Chalk andTalk are used for Problem Solving	
UNIT IV	**8**

Complex Numbers, Functions and Differentiation: Geometric Representation, Polar Form of Complex Numbers, Powers and Roots, Analytic Function, Cauchy–Riemann Equations, Exponential Function, Trigonometric and Hyperbolic Functions.	**hours**
Teaching Learning Process : Power-point Presentation, Video demonstration or Simulations, Chalk andTalk are used for Problem Solving	
UNIT V **Calculus of Variation:** Introduction, Examples of Simple Functionals, The first Variation (Euler - Lagrange Equation), Brachistochrone problem. Isoperimetric problems. Rayleigh Ritz method -problems.	**7 hours**
Teaching Learning Process: Video demonstration or Simulations, Chalk andTalk are used for Problem	

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Determine the rate of changes, extreme values, rank ofa matrix.
CO2: Solve ordinary differential equation and system of linear equations.
CO3: Test consistency of linear equations, the independency of two functions of two Identical independent variables.
CO4: Describe Model and find the solutions for First Order and Second Order ODEs and find solutions to Functionals..
CO5: Identify the mathematical techniques of solving ordinary differential equations.
TEXT BOOKS 1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons. 2. Door Irving Herman Shames, Clive L. Dym , "Energy and Finite Element Methods in Structural Mechanics", 1st Edition, 2015 Reprint, New Age International. Web links and Video Lectures (e-Resources): 1. Differential Equations for Engineers https://archive.nptel.ac.in/courses/111/106/111106100/ 2. Ordinary and Partial Differential Equations and Applications https://onlinecourses.nptel.ac.in/noc22_ma02/preview

CO1	**PO1**	**PO2**	**PO3**	**PO4**	
CO2	1		3		2
CO3		2	1	3	
CO4	3		1	2	
CO5		3		1	2
	2		3		1

QUESTION PAPER PATTERN:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reducedto 50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have a sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module mostone full question from each unit.

SIGNAL ANALYSIS AND CONDITION MONITORING

Course Code	**22MDE12**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab Sessions	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

This course will enable students to

1. Know the concepts used for kinematic analysis of planar and spatial mechanisms.
2. Familiarize with the concepts of synthesis of mechanisms.

UNIT-1 (8 Hours)

Introduction: Basic concepts. Fourier analysis. Bandwidth. Signal types. Convolution.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for ProblemSolving, Laboratory Demonstrations and Practical Experiments

UNIT-2 (8 Hours)

Signal analysis: Filter response time. Detectors. Recorders. Analog analyzer types.

Teaching-LearningProcess	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for ProblemSolving, Laboratory Demonstrations and Practical Experiments

UNIT-3 (8 Hours)

Practical analysis of stationary signals: Stepped filter analysis. Swept filter analysis. High speed analysis. Real-time analysis.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for ProblemSolving, Laboratory Demonstrations and Practical Experiments

UNIT-4 (8 Hours)

PRACTICAL COMPONENT OF IPCC		
	Sl.NO.	**Experiments**
	1	Natural frequency determination of Simple Harmonic Motion using simple Pendulum
	2	Determination of Damping ratio using spring mass system (Single DOF)
	3	Determination of Natural Frequency under forced vibration of Cantilever Beam
	4	Mode Shape analysis of Multi Degree of System using MATLAB
	5	FFT in MATLAB
	6	Critical Frequency determination using whirling of shaft without load
	7	Critical Frequency determination using whirling of shaft with load
	8	Determination of Transfer Function of Magnetic Levitation

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

- Two Tests each of **20 Marks**
- Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
- Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl.No	Descriptions	Blooms Level
CO1	Discuss different types of signals generated	3
CO2	Apply the various techniques for signal conditioning.	4
CO3	Apply various condition monitoring techniques	3
CO4	Apply practical analysis of continuous non-stationary signals	2
CO5	Apply visual monitoring and signature analysis of integrated Vehicle.	3

Mapping of COS and POs

Course Out Comes	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO1.	3			2	1
CO2.		2	1	3	
CO3.	1		2		3
CO4.		3		1	2
CO5.	2		3		1

ADVANCED THEORY OF VIBRATIONS

Course Code	**22MMD13**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40+ 10-12 Activities	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

1. To study the basic concepts of vibration.
2. To characterize the free and forced vibrations of damped and undimmed single degreeoffreedom systems.
3. To understand the transient vibration response of a single degree of freedom system.
4. To study various vibration measuring instruments.
5. To study and characterize the random vibrations.
6. To characterize the continuous systems.

MODULE-1(9 Hours)

Introduction: Elements of vibratory system, examples of vibratory motions, simple harmonic motion, degrees of freedom.**System with One Degree of Freedom:** Equations of motion by Newton's method & Energy method,general solution, frequency response method. Undamped free vibration and damped free vibration.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for ProblemSolving, Laboratory Demonstrations and Practical Experiments

MODULE-2(9 Hours)

Forced Vibration of Single Degree of Freedom System, Several degrees of freedom system, MDOF Systems: Undamped forced vibration – harmonic excitation, damped forced vibration – harmonic excitation, rotating and reciprocating unbalance, vibration isolation and transmissibility, system
attached to moving support.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for ProblemSolving, Laboratory Demonstrations and Practical Experiments

MODULE-3 (7 Hours)

Vibration Measurements: Introduction, transducers, vibration measuring instruments – vibrometers and accelerometers, frequency measuring instruments, vibration exciters, signal analysis. **Random Vibrations:** Introduction, random variables and random processes, probability distribution, mean value and standard deviation, correlation functions of a random process, stationary random process, Gaussian random process, Fourier transforms and response, power spectral density.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for ProblemSolving, Laboratory Demonstrations and Practical Experiments
MODULE-4 (8 Hours)	
Continuous Systems: Introduction, continuous system – a simple exposition, separation of time and space variables, problems governed by wave equation: longitudinal vibrations of rods & torsional vibration of shaft, lateral vibration of beams.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for ProblemSolving, Laboratory Demonstrations and Practical Experiments
MODULE-5 (7 Hours)	
Transient Vibration of Single Degree of Freedom System: Introduction, Derivation of ConvolutionIntegral – response due to unit impulse, Response due to a General Excitation, Excitations Whose Forms Change at Discrete Times, Transient Motion Due to Base Excitation, Laplace Transform Solutions, Transfer Functions, Numerical Methods, Shock Spectrum, Vibration Isolation for Short Duration Pulses.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for ProblemSolving, Laboratory Demonstrations and Practical Experiments

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marksin SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures notless than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy asper the outcome defined for the course.

Semester End Examination:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionatelyreduced to 50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have a sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Francis S. Tse, Ivan E. Morse, Rolland T. Hinkle, "Mechanical Vibrations - Theory andApplications", Allyn and Bacon, Inc., 2004, ISBN-10: 8123908466 / ISBN-13: 978- 8123908465.
2. S. Graham Kelly, "Mechanical Vibrations – Thoery and Applications", Cengage Learning, 2012, ISBN-10: 1-4390-6214-5 / ISBN-13: 978-1-4390-6214-2.
3. Amiya R. Mohanty, "Machinery Condition Monitoring", CRC Press, 2015, ISBN-13: 978-1-4665-9305-3.

Web links and Video Lectures (e-Resources):

1. NOC:Introduction to Mechanical Vibration, IITRoorkee (https://nptel.ac.in/courses/112107212)
2. Mechanical Vibrations, IIT Guwahati (https://nptel.ac.in/courses/112103112)
3. http://va-coep.vlabs.ac.in/List%20of%20experiments.html

Skill Development Activities Suggested

1. Write MATLAB/ SCILAB programs to simulate the response of single degree of freedom systemsunder free and forced vibrations.
2. To create mathematical models of single degree of freedom systems in MATLAB Simulink /SCILAB.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl.No	Description	Blooms Level
CO1	Discuss the basics of vibrations and determine the equations of motion for free & forced vibrations of single degree of freedom systems .	3
CO2	Determine the response of a single degree of freedom system subjected to 3 various types of input forces.	3
CO3	Apply fundamentals of vibrations to its measurement and analysis	3
CO4	Determine the equations of motion for continuous system and to find their 3 solutions.	3
CO5	Discuss and apply these concepts for condition monitoring of machines	3

Mapping of COS and POs

Course Out Comes	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO1	**1**		**2**	**3**	
CO2	**2**	**3**	**1**		
CO3		**2**		**1**	**3**
CO4		**1**	**3**	**2**	
CO5	**3**				**1**

ADVANCED MECHANISM DESIGN

Course Code		CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	25 + 10-12 Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

1. Know the concepts used for kinematic analysis of planar and spatial mechanisms.
2. Familiarize with the concepts of synthesis of mechanisms.

MODULE-1 (8 Hours)

Introduction, Overview, Why Simulate Mechanisms, Kinematics Simulations, Dynamic Simulation of Mechanisms, Summary, Vector Loop and Vector Chain Equations –Introduction, The Planar Vector, Single Loop Equations, Derivatives of Vectors, Other Common Mechanisms, Vector Chains.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for ProblemSolving, Laboratory Demonstrations and Practical Experiments

MODULE-2(8 Hours)

Introduction to synthesis (analytical methods) - Freudenstein's equation - Precision point, approximation - Precision derivative approximation - Method of components - Block synthesis andReven's method.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for ProblemSolving, Laboratory Demonstrations and Practical Experiments

MODULE-3 (8 Hours)

Graphical Synthesis Techniques: Motion generation for two prescribed positions and three prescribed positions – path generation for three prescribed positions without and with prescribed timing – function generation for three prescribed positions.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for ProblemSolving, Laboratory Demonstrations and Practical Experiments

MODULE-4 (8 Hours)

Analytical Synthesis Techniques: Four bar and slider crank function generator with three accuracy points– use of complex numbers and dyads – three prescribed positions for motion, path andfunction generation using dyad.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for ProblemSolving, Laboratory Demonstrations and Practical Experiments

MODULE-5 (8 Hours)

Two-link planar Robot: Overview, Vector Equations, Dynamic Equations, The Simultaneous Constraint matrix, Dynamic Simulation, Robot Coordinate Control.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for Problem Solving, Laboratory Demonstrations and Practical Experiments

Suggested Learning Resources:

Books

1. Uicker, Pennock and Shigley," Theory of machines and Mechanisms", Oxford University Press, 2010.
2. AmitabhaGhosh and Ashok Kumar Mallik, "Theory of Mechanism and machines", East West Press pvt Ltd, 2nd edition.
3. S.S. Rattan, "Theory of Machines", Tata McGraw Hill, 2011.

Web links and Video Lectures (e-Resources):

1. NOC:Kinematics of Mechanisms and Machines, IITKharagpurhttps://nptel.ac.in/courses/112105268
2. Kinematics Of Machineshttps://www.youtube.com/watch?v=MJeRFzs4oRU&list=RDCMUC640y4UvDAlya_WOj5U4pfA&index=2

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Write a MATLAB Program for kinematic analysis of Fourbar mechanism
2. Write a program in MATLAB to simulate the forward kinematics of a 2R Robotic Arm.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl.No	Description	Blooms Level
CO1	Apply path curvature characteristics in analysis of mechanisms.	3
CO2	Apply analytical and synthesis techniques in design of mechanisms.	4
CO3	Apply forward and reverse kinematic analysis techniques in performance evaluation of manipulators	3
CO4	Apply analytical and synthesis of four bar mechanisms through techniques.	2
CO5	Apply and analysis The Simultaneous Constraint and Dynamic Simulation of a Robot Control.	2

Mapping of COS and POs

Course Out Comes	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO1	**3**		**3**		**2**
CO2			**1**	**3**	**2**
CO3	**2**		**3**	**1**	
CO4			**1**	**3**	**2**
CO5	**1**	**2**		**3**	

ADVANCED MECHANICS OF SOLIDS

Course Code	**22MMD15**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 + 10-12 Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To familiarize with the concepts of stresses and strains in un symmetric bending andtorsion using classical meth
2. To be conversant with the concept of energy methods applied in elasticity.

MODULE-1 (5 Hours)

Theories of Stress: The state of stress at a point, normal and shear stress components, rectangularstress components,str an arbitrary plane, principal stresses octahedral stress. Equilibrium equations for plane stress state,boundary condition.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for Problem Demonstrations and Practical Experiments

MODULE-2 (5 Hours)

Theories of Strain: deformation, deformation in the neighbourhood of a point, change in length of alinear element, ch element – linear components, change in direction of linear elements, change in the angle between two line

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for Problen Demonstrations and Practical Experiments

MODULE-3(5 Hours)

Stress–Strain Relations &Energy Methods: Generalised statement of hook's law , stress – strain relation for isotro between the elastic constants, initiation of yield, yield criteria,The principle of superposition, work done by forces ar stored, reciprocal relation. Maxwell-Betti-Rayleigh reciprocal theorem, superposition of elastic ene

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for ProblemSo Demonstrations and Practical Experiments

MODULE-4 (5 Hours)

Axisymmetric Problems: Thick – walled cylinder subjected to internal and external pressure, stresses due togravitatio uniform thickness, disk of variable thickness rotatingcylinders.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for Problem Demonstrations and Practical Experiments

MODULE-5 (5 Hours)

Torsion: Introduction, Torsion of general prismatic bars – Solid sections, Torsion of Circular and Elliptical bars, Torsi triangular bar, Torsion of rectangular bars, Membrane analogy, Torsion of thin walled tubes, Torsion of thin walled mu sections, Multiple connected
sections, Centre of twist and flexure centre

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk areused for ProblemSo Demonstrations and Practical Experiments

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The m
the CIE is 50% of the maximum marks. Minimum passing marksin SEE is 40% of the maximum marks of SEE. A
have satisfied the academicrequirements and earned the credits allotted to each subject/ course if the student secur
marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examinat

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy asper the outco

Semester End Examination:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionatelyreduced to
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions)
- Each full question will have a sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module

.

Suggested Learning Resources:

Books

1. Boresi& Sidebottom, "Advanced Mechanics of materials" Wiely International, 6th edition.
2. Dr Sadhu Singh, "Strength of materials" Khanna Publication, 1st edition
3. Timoshenko S. P. and Goodier J. N., "Theory of elasticity", McGraw- Hill Publishers, 3rdEdition.
4. L. S. Srinath, "Advanced Mechanics of Solids", McGraw Hill Education (India) Pvt. Ltd., 3rdedition

Web links and Video Lectures (e-Resources):

1. Advanced Solid Mechanics: https://archive.nptel.ac.in/content/storage2/courses/105106049/lecnotes/main.htm
2. NOC:Solid Mechanics, IIT Delhi : https://nptel.ac.in/courses/112102284
3. Advanced Strength of Materials, IIT Bombay :https://nptel.ac.in/courses/112101095

Skill Development Activities Suggested

1. Use the tensor notation to represent the equations for Elasticity
2. Find the stress concentration factors from FEM and copare with elastic solutions
3. Explore the technique of image processing to estimate the surface strains on a loaded body.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl.No	Descriptions	Blooms Level
CO1	Apply basic concepts in continuum mechanics of solids viz. Stressand strain tensors, equilibrium, compatibility and constitutive equations and methods of solution to elasticity Problems.	3
CO2	Evaluate stresses and displacements in simple solids such as pressurized cylinders, shrink fitted cylinders, rotating disc and shaft,plate with hole and non-circular shafts and thin tubes Under torsion.	4

CO3	Examine bodies subjected to three dimensional stresses for the onset offailure based on failure Criteria.	3
CO4	Analyze deflections in beams subjected to different types of loads forelastic, elastoplastic and Plastic conditions.	2
CO5	Evaluate stresses in bars subjected to torsion for elastic, elasto plasticand plastic conditions.	2

Mapping of COS and POs

Course Out Comes	**Program Outcomes**				
	PO1	PO2	PO3	PO4	PO5
CO1	**2**	**1**	**3**		
CO2		**2**		**3**	**1**
CO3	**3**		**1**	**2**	
CO4		**2**	**1**		**3**
CO5	**1**	**3**	**2**		

Course Title: RESEARCH METHODOLOGY AND IPR

Course Code: **22RM16**	CIE + Assignment + Group Activity + Seminar +SEE Marks = 30 + 10 + 5 + 5 + 50 = 100
Credits: 03	
Hours: 50 Hrs. (L:T:P:S:3:0:0:0)	SEE Duration: 3 Hrs.

Course Learning Objectives:

1	To make students learn the research methodology and the technique of defining a research problem
2	To understand the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
3	To discuss the research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
4	To parametric tests of hypotheses and various forms of the intellectual property

UNIT – I

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.	**10 Hrs**

UNIT – II	
Reviewing the literature: Place of the literature review in research, bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. Research Design: Meaning of Research Design, Need for Research Design, features of a Good Design, ImportantConcepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.	**10 Hrs**
UNIT – III	
Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale. Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.	**10 Hrs**
UNIT – IV	
Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.	**10 Hrs**
UNIT – V	
Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999, The Designs Act, 2000, The Geographical	**10 Hrs**
Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder	

Course Outcomes: The students will be able to	
1	Discuss research methodology and the technique of defining a research problem
2	Explain the functions of the literature review in research, carrying out a literature search, developing Theoretical and conceptual frameworks and writing a review.
3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections. impact in the changing global business environment and Leading International Instruments concerning IPR.
4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
5	Discuss various forms of the intellectual property, its relevance and business impact in the changing Global business environment and leading International Instruments concerning IPR.

Reference Books:	
1	Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International, 4th Edition, 2018.

2	Research Methodology a step-bSy-step guide for beginners. Ranjit Kumar, SAGE Publications, 3 rd Edition, 2011. (For the topic Reviewing the literature under module 2),
3	Study Material, (For the topic Intellectual Property under module 5), Professional Programme Intellectual
4	Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013

CO-PO Mapping						
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	□		□			□
CO2	□	□				
CO3	□		□	□	□	
CO4	□		□			
CO5	□			□	□	

Course Code: **22MMDL17**	**NUMERICAL SIMULATIONS LABORATORY**	CIE Marks	50
eaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Total Hours of Pedagogy	15 + 10 **-12 Laboratory Sessions**	Total Marks	100
Credits	2	Exam Hours	3

Course objectives:

To familiarize the students with a Scientific Computing Software such as MATLAB/SCILAB/PYTHON

To Solve ODEs and other mathematical problems numerically.

.NO	EXPERIMENTS
1	Introduction to MATLAB/SCILAB 1: Basics, Creating Arrays,
2	Introduction to MATLAB/SCILAB 2: Mathematical Operations, Script Files, 2D and 3D Plots, Functions a Programming. Applications
3	Introduction to MATLAB/SCILAB 3: 2D and 3D Plots, Functions and Programming.Applications
4	Solve theFirst Order Differential Equation: $\frac{dy}{dt} = t^{-2y}$ for $1 < t < 3$ and $y = 4.2$ at $t =$ 1using MATLAB and plot the solution
5	Solve a Second-Order Differential Equation Numerically: $\frac{d^2y}{dx^2} = (1 - y^2)\frac{dy}{dx} - y$using MATLAB and plot the solution.
	DEMONSTRATION EXPERIMENTS (FOR CIE)
9	Write a MATLAB Code for solving ODEs using approximate Method of weighted residuals differential equatio (y''+y-4*x=0) and (y'+y=1, for y(0)=1, y(1)=0) using four methods: Point Collocation, Sub Domain, Least Squar and Galerkin's. Compare the results with one another and with exact solution.
10	Solve in MATLAB/SCILAB Using Variational Method (Ritz Method) : $-\frac{d^2y}{dx^2} - y + x^2$for $0 < x < 1$ with boundary conidtions: $y(0) = 0$ and $y(1) = 0$
11	Write a MATLAB code for solving 2nd-order homogeneous, constantcoefficientsBVPs viaGalerkin's Method over " n" elements:
12	Write a python program function *gaussQuad2* that computes $\iint_A f(x, y)\, dx\, dy$ over aquadrilateral element with Gauss-Legendre quadrature of integration order m.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Model simple to complicated kinematic systems independently
- Analyse and interpret the commonly occurring kinematic systems in a commercial software
- Verify the results of simulations of a commercial software with Analytical Methods

ssessment Details (both CIE and SEE)

he weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimu ssing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requiremen d earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semeste d examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session an made known to students at the beginningof the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write- upwill be evaluated for marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8thweek of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and proceduralknowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two testsis the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute; examiners are appointedby the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by t examiners. **OR** based on the course requirement evaluation rubrics shallbe decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-vo 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 5 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be

Made zero. The duration of SEE is 03 hours

Suggested Learning Resources:

1. Amos Gilat, MATLAB, An Introduction with Applications, John Wiley & Sons, 4th Edition orlater, 2011
2. Achuthsankar S Nair, SCILAB (A Free Software To MATLAB), S Chand Publishing, 2012
3. https://www.scilab.org/about/community/books
4. https://www.mathworks.com
5. https://www.python.org/
6. Al Sweigart, "Automate the Boring Stuff with Python: Practical Programming for Total Beginners", No Starch Press, (https://automatetheboringstuff.com/)
7. JaanKiusalaas, Numerical Methods in Engineering with Python 3, Cambridge University Press,2013
8. https://in.mathworks.com/help/symbolic/solve-a-single-differential-equation.html
9. https://in.mathworks.com/help/symbolic/solve-differential-equation-numerically-1.html
10. AngwenyiDavid Variational Methods: The Ritz Method (https://www.mathworks.com/matlabcentral/fileexchange/102599-variational-methods-the-ritz-method), MATLAB Central File Exchange. Retrieved November 12, 2022..
11. https://www.researchgate.net/publication/324536698_A_lecture_note_on_MATLAB_code_for_solving_2_nd-order_homogeneous_constant_coefficients_BVPs_via_Galerkin's_Method_over_ne_elements/link/5ad4321aa6fdcc29357ffa67/download
12. MATLAB code for solving 2nd-order homogeneous, constant coefficients BVPs via Galerkin's Method over "n_e" elements: https://www.researchgate.net/publication/324536698_A_lecture_note_on_MATLAB_code_for_solving_2_nd-order_homogeneous_constant_coefficients_BVPs_via_Galerkin%27s_Method_over_ne_elements
13. https://in.mathworks.com/matlabcentral/fileexchange/79667-method-of-mean-weighted-residuals-example
14. https://in.mathworks.com/matlabcentral/fileexchange/79068-weighted-residue-method-for-bar- problem
15. https://www.me.ua.edu/me611/f02/pdf/mwr.pdf
16. Amos Gilat, MATLAB, An Introduction with Applications, John Wiley & Sons, 4th Edition orlater, 2011
17. Achuthsankar S Nair, SCILAB (A Free Software To MATLAB), S Chand Publishing, 2012
18. https://www.scilab.org/about/community/books
19. https://www.mathworks.com
20. https://www.python.org/
21. Al Sweigart, "Automate the Boring Stuff with Python: Practical Programming for Total Beginners", No Starch Press, (https://automatetheboringstuff.com/)
22. JaanKiusalaas, Numerical Methods in Engineering with Python 3, Cambridge University Press,2013
23. https://in.mathworks.com/help/symbolic/solve-a-single-differential-equation.html
24. https://in.mathworks.com/help/symbolic/solve-differential-equation-numerically-1.html
25. Angwenyi David Variational Methods: The Ritz Method (https://www.mathworks.com/matlabcentral/fileexchange/102599-variational-methods-the-ritz-method), MATLAB Central File Exchange. Retrieved November 12, 2022..
26. https://www.researchgate.net/publication/324536698_A_lecture_note_on_MATLAB_code_for_solving_2_nd-order_homogeneous_constant_coefficients_BVPs_via_Galerkin's_Method_over_ne_elements/link

/5ad4321aa6fdcc29357ffa67/download

27. MATLAB code for solving 2nd-order homogeneous, constant coefficients BVPs via Galerkin's Method over "n_e" elements: https://www.researchgate.net/publication/324536698_A_lecture_note_on_MATLAB_code_for_solving_2_nd-order_homogeneous_constant_coefficients_BVPs_via_Galerkin%27s_Method_over_ne_elements
28. https://in.mathworks.com/matlabcentral/fileexchange/79667-method-of-mean-weighted-residuals-example
29. https://in.mathworks.com/matlabcentral/fileexchange/79068-weighted-residue-method-for-bar- problem https://www.me.ua.edu/me611/f02/pdf/mwr.pdf

Made zero. The duration of SEE is 03 hours

Suggested Learning Resources:

30. Amos Gilat, MATLAB, An Introduction with Applications, John Wiley & Sons, 4th Edition orlater, 2011
31. Achuthsankar S Nair, SCILAB (A Free Software To MATLAB), S Chand Publishing, 2012
32. https://www.scilab.org/about/community/books
33. https://www.mathworks.com
34. https://www.python.org/
35. Al Sweigart, "Automate the Boring Stuff with Python: Practical Programming for Total Beginners", No Starch Press, (https://automatetheboringstuff.com/)
36. JaanKiusalaas, Numerical Methods in Engineering with Python 3, Cambridge University Press,2013
37. https://in.mathworks.com/help/symbolic/solve-a-single-differential-equation.html
38. https://in.mathworks.com/help/symbolic/solve-differential-equation-numerically-1.html
39. Angwenyi David Variational Methods: The Ritz Method (https://www.mathworks.com/matlabcentral/fileexchange/102599-variational-methods-the-ritz-method), MATLAB Central File Exchange. Retrieved November 12, 2022..
40. https://www.researchgate.net/publication/324536698_A_lecture_note_on_MATLAB_code_for_solving_2_nd-order_homogeneous_constant_coefficients_BVPs_via_Galerkin's_Method_over_ne_elements/link/5ad4321aa6fdcc29357ffa67/download
41. MATLAB code for solving 2nd-order homogeneous, constant coefficients BVPs via Galerkin's Method over "n_e" elements: https://www.researchgate.net/publication/324536698_A_lecture_note_on_MATLAB_code_for_solving_2_nd-order_homogeneous_constant_coefficients_BVPs_via_Galerkin%27s_Method_over_ne_elements
42. https://in.mathworks.com/matlabcentral/fileexchange/79667-method-of-mean-weighted-residuals-example
43. https://in.mathworks.com/matlabcentral/fileexchange/79068-weighted-residue-method-for-bar-problem https://www.me.ua.edu/me611/f02/pdf/mwr.pdf

2ND SEM SYLLABUS

ADVANCED MACHINE DESIGN

Course Code	**22MMD21**	CIE Marks	50
Teaching Hours/Week(L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

1. Introduce basic aspects of Fatigue and Failure.
2. Discuss the availability of various fatigue analysis methods that are used by professional.
3. Know the modifications required in case of mean stress and notches
4. To understand various cycle counting methods used in industries and in commercial software.
5. Familiarize with the fatigue of spot welds.

UNIT-1 (8Hours)

INTRODUCTION: Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples.

FATIGUE OF MATERIALS: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-2 (8Hours)

FATIGUE FROM VARIABLE AMPLITUDE LOADING: Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-3 (8Hours)

SURFACE FAILURE: Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-4 (8Hours)

STRESS-LIFE (S-N) APPROACH: S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behavior, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach.

STRAIN-LIFE(E-N) APPROACH: Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-

strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments
UNIT-5 (8Hours)	
LEFM APPROACH: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber's rule, Glinka's rule, applications of fracture mechanics to crack growth at notches.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE.A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE(Semester End Examination) taken together

CIE

- Two Tests each of3**0Marks**
- Two assignments each of 20 Marks or one Skill Development Activity of 40 marksto attain the COs and POs
- The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks
- CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

SEE

- Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course(duration 03 hours)
- Thequestionpaperwillbesetfor100marksandmarksscoredwillbescaleddownproportionately to50 marks.
- The question paper will have ten questions. Each question is set for20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5full questions, selecting one full question from each module.
- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE).

Suggested Learning Resources:

Books

1. Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, "Metal Fatigue in engineering", John Wiley New York, Second edition. 2001.
2. Failure of Materials in Mechanical Design, Jack. A. Collins, John Wiley, New York 1992.
3. Robert L. Norton, "Machine Design", Pearson Education India, 2000
4. S. Suresh, "Fatigue of Materials", Cambridge University Press, -1998
5. Julie. A. Benantine, "Fundamentals of Metal Fatigue Analysis", Prentice Hall,1990
6. Fatigue and Fracture, ASM Hand Book, Vol 19,2002.

Sl. No	Descriptions	Blooms Level
CO1	Will be able to differentiate high cycle fatigue and low cycle fatigue	3
CO2	Will be able to cycle counting and do life estimation	3
CO3	To calculate Surface fatigue strength	2
CO4	To draw SN curve using strain life and stress approach	3

Mapping of Cos and POs

Course Out Comes	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO1.	3				1
CO2.	3				1
CO3.	3				1
CO4.	3				1

Note:High-1,Medium–2,and Low – 3

ADVANCED FINITE ELEMENT METHODS & APPLICATIONS			
Course Code	**22MMD22**	CIE Marks	50
Teaching Hours/Week(L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab Sessions	Total Marks	100
Credits		Exam Hours	03

Course Learning objectives:

This course will enable students to

1. To learn the theory and characteristics of finite elements that represent engineering structures.
2. To learn and apply finite element solutions to structural, dynamic problem and non linear problems

UNIT-1(8Hours)	
Basic Concepts of Finite Element Analysis, Integral formulations, variational methods, weighted residual methods, weak formulations of boundary value problems, one dimensional problems, Shape function Stiffness, traction and body force vectors of the linear bar element, quadratic bar element, 2-D Constant strain triangular element, 2-D linear triangular element, 4 noded quadrilateral element, 9-noded quadrilateral element and serendipity elements.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments
UNIT-2(8Hours)	
Bending of beams, Stages of plastic yielding, Analyses of stresses, Nonlinear stress-strain curve, Shear stress distribution, residual stresses in plastic bending. Introduction to Torsion, Plastic torsion of a circular bar, elastic perfectly plastic material. Elastic work hardening of materials, residual stresses.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments
UNIT-3 (8Hours)	
Two dimensional problems, Interpolation Functions, Postprocessing, Axisymmetric Solids: Structures of Revolution, Axisymmetric Solid Iso-P Elements, Iso-P Quadrilateral Ring Elements, A Complete Axisymmetric FEM Program. Axisymmetric Solid Benchmark Problems	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments
UNIT-4(8Hours)	
Dynamic Analysis: Introduction – simple harmonic oscillator, multi degrees of freedom systems, equation of motion, longitudinal vibration of bars – transverse vibration of beams – consistent mass matrices, eigen values and eigen vectors, modeling of damping, solution methods: polynomial iteration, matrix iteration and cholesky method.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments
UNIT-5(8Hours)	
Introduction to nonlinear systems in solid mechanics, geometric nonlinearity, material nonlinearity. Kinematic nonlinearity, force nonlinearity. Solution procedures for nonlinear algebraic equations. Newton–Raphson method, modified Newton–Raphson method, Steps in the solution of nonlinear finite element analysis.	

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

PRACTICAL COMPONENT OF IPCC

Sl.NO.	Experiments
1	FEA of Bars tapered cross section area and stepped bars.
2	Analysis of Simply Supported Beams with different loading conditions
3	Analysis of Cantilever Beams with different loading conditions
4	Stress analysis of rectangular plate with circular hole
5	Stress analysis of Axisymmetric problems –rotating disc
6	Modal Analysis of Cantilever Beams
7	Harmonic analysis of Bar subjected to forcing function
8	Contact analysis problem

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE.A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE(Semester End Examination) taken together

CIE for the theory component of IPCC

- Two Tests each of 3**0 Marks**
- Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day.The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- TheCIEmarksawardedinthecaseofthePracticalcomponentshallbebasedonthecontinuous evaluation of the laboratory report. Each experiment report can be evaluated for 10marks.Marks of all experiments 'write-ups are added and scaled down to15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for50marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course(duration 03 hours)

- Thequestionpaperwillbesetfor100marksandmarksscoredwillbescaleddownproportionately to50 marks.
- The question paper will have ten questions. Each question is set for20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3sub-questions), **should have a mix of topics** under that module.

- The students have to answer 5full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE papers hall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15(50%ofmaximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50%of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Books

1. Chandrupatla T. R., and Belegundu, A.D., Introduction to Finite Elements in Engineering, Prentice Hall, 2003.
2. Reddy, J. N. An Introduction to the Finite Element Method, 3rd Edition, McGraw-Hill Science/Engineering/Math, 2005.
3. The Finite Element Method in Engineering, S. S. Rao, Fifth Edition, Elsevier Publications.
4. Thomas Apel and Olaf Steinbach, "Advanced Finite Element Methods and Applications", Springer Publications, ISBN 978–3–642–30315–9, 2013
5.Fundamentals of FEM, Hutton, Tata McGraw Hill education Pvt. Ltd, 2005, ISBN: 070601224

Sl.No	Description	Blooms Level
CO1	Understand the concepts behind formulation methods in FEM.	2
CO2	Identify the application and characteristics of FEA elements such as one dimensional, two dimensional and three dimensional elements.	3
CO3	To apply solution methods to dynamic problems and analyze	4
CO4	Model and analyze the nonlinear behavior of different mechanical systems using advanced software tools.	3

Mapping of COs and POs

Course Out Comes	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO1.	3				1
CO2.	3				1
CO3.	3				1
CO4.	3				1

Note:High-1,Medium–2,and Low – 3

OPTIMIZATION TECHNIQUES

Course Code	**22MMD231**	CIE Marks	50
Teaching Hours/Week(L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

1. To introduce the concepts of dynamic measurements and analysis of experimental data.
2. To expose them to the techniques of Data Acquisition, Signal conditioning and processing.
3. To introduce students to different aspects of measuring deformation, strains, and stresses for developing a mechanistic understanding of both the material and the structure behavior.

UNIT-1(8Hours)

Introduction: Definition of terms, calibration, standards, dimensions and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning. Analysis of Experimental Data: Cause and types of experimental errors, error analysis. Statistical analysis of experimental data- Probability distribution, gaussian, normal distribution. Chi-square test, Method of least square, correlation coefficient, multivariable regression, standard deviation of mean, graphical analysis and curve fitting, general consideration in data analysis.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-2(8Hours)

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. Force, Torque and Strain Measurement: Mass balance measurement, Elastic Element for force measurement, torque measurement. Strain Gages -Strain sensitivity of gage metals, Gage construction, Gage sensitivity and gage factor, Performance characteristics, Environmental effects 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.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-3 (8Hours)

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 Polaris copes, Isoclinics Iso chromatics fringe order determination - Fringe multiplication techniques - Calibration Photoelastic model materials. Separation methods shear difference method, Analytical

separation methods, Model to prototype scaling.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments
UNIT-4(8Hours)	
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, Principals, Polari scope and stress data analyses.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments
UNIT-5(8Hours)	
Coating Methods: **Photo elastic Coating Method**-Birefringence coating techniques Sensitivity Reinforcing and thickness effects - data reduction - Stress separation techniques Photo elastic strain gauges. **Brittle Coatings Method:** Brittle coating technique Principles data analysis - coating materials, Coating techniques. **Moire Technique** - Geometrical approach, Displacement approach- sensitivity of Moire data data reduction, In plane and out plane Moire methods, Moire photography, Moire grid production. 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, Realtime. and double exposure methods, Displacement measurement, Isopachics.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE.A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures notless than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE(Semester End Examination) taken together

CIE

- Two Tests each of 3**0Marks**
- Two assignments each of 20 Marks or one Skill Development Activity of 40 marks to attain the COs and POs
- The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks
- CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

SEE

- Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course(duration 03 hours)
- The question paper will be set for100 marks and marks scored will be scaled down proportionately to50 marks.
- The question paper will have ten questions. Each question is set for20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5full questions, selecting one full question from each module.
- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE).

Suggested Learning Resources:

Books

1. Holman, "Experimental Methods for Engineers" 7th Edition, Tata McGraw-Hill Companies, Inc, New York, 2007.
2. R. S. Sirohi, H. C. Radha Krishna, "Mechanical measurements" New Age International Pvt. Ltd., New Delhi, 2004 .
3. Experimental Stress Analysis - Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, Tata McGraw Hill, 1984.
4. Instrumentation, Measurement And Analysis -Nakra&Chaudhry, B C Nakra K KChaudhry, Tata McGraw-Hill Companies, Inc, New York, Seventh Edition, 2006.

Sl.No	Descripition	Blooms Level
CO1	Undertake experimental investigations to verify predictions by other methods.	3
CO2	To acquire skills for experimental investigations an accompanying laboratory course is desirable.	3
CO3	To analyze fringe patterns, calibration studies.	2
CO4	Analysis and evaluations of polariscope.	3

CO5	Study and evaluation techniques of coating technology.	2

MappingofCOSandPOs

Course Out Comes	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO5.	1				1
CO6.	3				1
CO7.	3				1
CO8.	3				1
CO9.	1				2

Note:High-1,Medium–2,and Low – 3

DESIGN OF EXPERIMENTS

Course Code	**22MMD232**	CIE Marks	50
Teaching Hours/Week(L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

1. Apply the principles of product design to modify existing engineering systems or to develop new artifacts.
2. Design a system taking into consideration the concepts of ease of production, maintenance, handling, installation etc.
3. Translate the concepts of economics in design, optimization of design and human factors approach to product design.

UNIT-1(8Hours)

Design for quality: Taguchi's Approach to Quality, On-line and Off-line Quality Control, Quality Loss Function, System Design, Parameter Design, Design for Environment, Human factor design, Design for casting and forging, Causes of Variation.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-2(8Hours)

Quality Function Deployment –Introduction, QFD team, benefits, voice of customer, organization of information, house of quality, QFD process

Design of Experiments: Basic methods- Two factorial experiments-Extended method reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional factorial design

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-3 (8Hours)

Failure Mode Effect Analysis: Refining geometry and layout, Failure tree analysis, Defects and failure modes Techniques of failure analysis, Filed inspection of failure, Macroscopic and Microscopic examination, Additional tests, Analysis of data and report of failure.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-4(8Hours)

Statistical Consideration in Product Design and Development

Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution- Statistical Process control–Scatter diagrams – Multivariable charts

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-5(8Hours)

Six Sigma – Overview, Basics and history of the approach for six sigma, Methodology and focus, the application of Six Sigma in production and in-service industries, Relationship of Six Sigma and Lean Management, linking Six Sigma project goals with organizational strategy

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

Assessment Details (both CIE and SEE)

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CIE

- Two Tests each of 3**0 Marks**
- Two assignments each of 20 Marks or one Skill Development Activity of 40 marks to attain the COs and POs
- The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks
- CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

SEE

- Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course(duration 03 hours)
- Thequestionpaperwillbesetfor100marksandmarksscoredwillbescaleddownproportionately to50 marks.
- The question paper will have ten questions. Each question is set for20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5full questions, selecting one full question from each module.
- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE).

Suggested Learning Resources:
Books

1. Total quality Management Kevin Otto & Kristin Wood, Product Design Techniques in Reverse
2. Engineering and New Product Development, Pearson Education (LPE), 2001.
3. Product Design and Development, Karl T. Ulrich, Steven D. Eppinger, TATA McGraw - HILL - 3rd Edition, 2003.
4. The Management and control of Quality, James R. Evens, William M Lindsay,6th edition- South-Western Publishers
5. Engineering Design, George E Dieter, 3rd Edition, McGraw hill International Edition

Sl.No	Description	Blooms Level
CO1	Apply a system based approach for quality management	3
CO2	Identify the importance of various principles of quality in product or service	3
CO3	Use statistical tools in product development	2
CO4	Apply basic risk analysis and experiment design techniques into practical cases	3
CO5	Demonstrate knowledge about Six sigma, Design of Experiments	2

Mapping of Cos and POs

Course Out Comes	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO10.	1				1
CO11.	3				1
CO12.	3				1
CO13.	3				1
CO14.	1				2

Note:High-1,Medium–2,and Low – 3

FATIGUE AND FAILURE ANALYSIS			
Course Code	**22MMD233**	CIE Marks	50
Teaching Hours/Week(L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

4. Introduce basic aspects of Fatigue and Failure.
5. Discuss the availability of various fatigue analysis methods that are used by professional.
6. Know the modifications required in case of mean stress and notches
7. To understand various cycle counting methods used in industries and in commercial software.
8. Familiarize with the fatigue of spot welds.

UNIT-1(8Hours)

Fatigue Damage Theories: Fatigue damage mechanism, Cumulative damage models, and Linear damage models, Double linear damage rule by Manson and Halford.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-2(8Hours)

Stress-Based Fatigue Analysis and Design: Introduction, The stress-life (S-N) and fatigue Limit testing, Estimated SN curve of a component based on ultimate tensile strength, Notch effect, Mean stress effect, Combined proportional loads.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-3 (8Hours)

Strain-Based Fatigue Analysis and Design: Introduction, Experimental test program, Analysis of Monotonic and cyclic stress–strain behavior of materials, Mean stress correction methods, Estimation of cyclic and fatigue properties, Notch analysis.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-4(8Hours)

Cycle Counting Techniques: One-parameter cycle counting methods, Two-parameter cycle counting Methods, Four-Point Cycle Counting Method, Reconstruction of a load-time history.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-5(8Hours)

Design Application of the Knowledge of Failure: Design considering fatigue-Gebers parabola, Soderberg equation, Lubricating optimally to combat bearing failures. Selection of materials to prevent seizure, galling, etc. Wear reduction techniques, Fracture toughness consideration in design.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

Assessment Details (both CIE and SEE)

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CIE

- Two Tests each of3**0Marks**
- Two assignments each of 20 Marks or one Skill Development Activity of 40 marks to attain the COs and POs
- The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks
- CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

SEE

- Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course(duration 03 hours)
- Thequestionpaperwillbesetfor100marksandmarksscoredwillbescaleddownproportionately to50 marks.
- The question paper will have ten questions. Each question is set for20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5full questions, selecting one full question from each module.
- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE).

Suggested Learning Resources:

Books

6. Yung-Li Lee, Jwo Pan, Richard Hathaway, Mark Barkey." Fatigue Testing and Analysis: Theory and Practice“, Elsevier, 2005.
7. Julie A. Bannantine, Jess J. Comer, James L. Handrock,”Fundamentals of Metal Fatigue Analysis”, Prentice Hall, 1990.
8. Ralph I. Stephens, Ali Fatemi, Robert R. Stephens, Henry O. Fuchs,”Metal Fatigue in Engineering”, John Wiley & Sons, 2000.
9. Anderson T L, “Fracture Mechanics: Fundamentals and Applications”, 4th Edition, CRC Press, 2017.
10. ASTM Standard E399, “Standard Test Method for Linear-Elastic Plane-Strain Fracture Toughness KIc of Metallic Materials,” ASTM International.

Sl.No	Description	Blooms Level
CO1	Correctly predict Fatigue life of metal components using Stress and Strain life Methods.	3
CO2	Analyze the situation to apply appropriate fatigue failure method	3
CO3	Identify and describe the basic fatigue mechanisms.	2
CO4	Demonstrate the application of the methods for fatigue life of spot Weld	3
CO5	Identify Design Application of the Knowledge of Failure	2

Mapping of Cos and POs

Course Out Comes	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO15.	1				1
CO16.	3				1
CO17.	3				1
CO18.	3				1
CO19.	1				2

Note:High-1,Medium–2,and Low – 3

PRODUCT DESIGN FOR QUALITY			
Course Code	**22MMD241**	CIE Marks	50
Teaching Hours/Week(L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

1. Apply the principles of product design to modify existing engineering systems or to develop new artifacts.
2. Design a system taking into consideration the concepts of ease of production, maintenance, handling, installation etc.
3. Translate the concepts of economics in design, optimization of design and human factors approach to product design.

UNIT-1(8Hours)

Design for quality: Taguchi's Approach to Quality, On-line and Off-line Quality Control, Quality Loss Function, System Design, Parameter Design, Design for Environment, Human factor design, Design for casting and forging , Causes of Variation.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-2(8Hours)

Quality Function Deployment –Introduction, QFD team, benefits, voice of customer, organisation of information, house of quality, QFD process

Design of Experiments: Basic methods- Two factorial experiments-Extended method reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional factorial design

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-3 (8Hours)

Failure Mode Effect Analysis: Refining geometry and layout, Failure tree analysis, Defects and failure modes Techniques of failure analysis, Filed inspection of failure, Macroscopic and Microscopic examination, Additional tests, Analysis of data and report of failure.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-4(8Hours)

Statistical Consideration in Product Design and Development

Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution- Statistical Process control–Scatter diagrams –Multivariable charts

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-5(8Hours)	
Six Sigma – Overview, Basics and history of the approach for six sigma, Methodology and focus, the application of Six Sigma in production and in-service industries, Relationship of Six Sigma and Lean Management, linking Six Sigma project goals with organizational strategy	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE.A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE(Semester End Examination) taken together

CIE

- Two Tests each of3**0Marks**
- Two assignments each of 20 Marks or one Skill Development Activity of 40 marks to attain the COs and POs
- The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks
- CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

SEE

- Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course(duration 03 hours)
- Thequestionpaperwillbesetfor100marksandmarksscoredwillbescaleddownproportionately to50 marks.
- The question paper will have ten questions .Each question is set for20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5full questions, selecting one full question from each module.
- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE).

Suggested Learning Resources:

Books

1. Total quality Management Kevin Otto & Kristin Wood, Product Design Techniques in Reverse
2. Engineering and New Product Development, Pearson Education (LPE), 2001.
3. Product Design and Development, Karl T. Ulrich, Steven D. Eppinger, TATA McGraw - HILL - 3rd Edition, 2003
4. The Management and control of Quality, James R. Evens, William M Lindsay,6th edition- South-Western Publishers
5. Engineering Design, George E Dieter, 3rd Edition, McGraw hill International Edition.

Sl.No	Description	Blooms Level
CO1	Apply a system based approach for quality management	3
CO2	Identify the importance of various principles of quality in product or service	3
CO3	Use statistical tools in product development	2
CO4	Apply basic risk analysis and experiment design techniques into practical cases	3
CO5	Demonstrate knowledge about Six sigma, Design of Experiments	2

Mapping of Cos and POs

Course Out Comes	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO1.	1				1
CO2.	3				1
CO3.	3				1
CO4.	3				1
CO5.	1				2

Note:High-1,Medium–2,and Low – 3

MECHATRONICS SYSTEMS DESIGN			
Course Code	**22MMD242**	CIE Marks	50
Teaching Hours/Week(L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

1. Introduce basic aspects of Fatigue and Failure.
2. Discuss the availability of various fatigue analysis methods that are used by professional.
3. Know the modifications required in case of mean stress and notches
4. To understand various cycle counting methods used in industries and in commercial software.
5. Familiarize with the fatigue of spot welds.

UNIT-1(8Hours)

INTRODUCTION: Definition and Introduction to Mechatronic Systems. Modeling &Simulation of Physical systems Overview of Mechatronic Products and their functioning, measurement systems. Control Systems, simple Controllers.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-2(8Hours)

STUDY OF SENSORS AND TRANSDUCERS: Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-3 (8Hours)

ELECTRICAL ACTUATION SYSTEMS: Electrical systems, Mechanical switches, Solid state switches, solenoids, DC & AC motors, Stepper motors.

System Models: Mathematical models:- mechanical system building blocks, electrical system building blocks, thermal system building blocks, electromechanical systems, hydro-mechanical systems, pneumatic systems.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-4(8Hours)

SIGNAL CONDITIONING: Signal conditioning, the operational amplifier, Protection, Filtering, Wheatstone Bridge, Digital signals , Multiplexers, Data Acquisition, Introduction to digital system processing, pulse-modulation.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-5(8Hours)

MEMS AND MICROSYSTEMS: Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process, Overview of Micro Manufacturing, Micro system Design, and Micro system Packaging

ADVANCED APPLICATIONS IN MECHATRONICS: Fault Finding, Design, Arrangements and Practical Case Studies, Design for manufacturing, User-friendly design

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

Assessment Details (both CIE and SEE)

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CIE

- Two Tests each of 3**0 Marks**
- Two assignments each of 20 Marks or one Skill Development Activity of 40 marks to attain the COs and POs
- The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks
- CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

SEE

- Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)
- Thequestionpaperwillbesetfor100marksandmarksscoredwillbescaleddownproportionately to50 marks.
- The question paper will have ten questions. Each question is set for20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5full questions, selecting one full question from each module.
- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE).

Suggested Learning Resources:
Books

6. W. Bolton, "Mechatronics" - Addison Wesley Longman Publication, 1999
7. HSU "MEMS and Microsystems design and manufacture"- Tata McGraw-Hill Education, 2002
8. Kamm,"Understanding Electro-Mechanical Engineering an Introduction to Mechatronics"- IEEE Press, 1 edition ,1996
9. Shetty and Kolk, "Mechatronics System Design"- Cenga ge Learning, 2010
10. HMT "Mechatronics"- Tata McGraw-Hill Education, 199 8

Sl.No	Description	Blooms Level
CO1	Appreciate multi-disciplinary nature of modern engineering systems.	3
CO2	Model and analyze mechanical and electrical systems and their connection.	3
CO3	Be able to integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.	2
CO4	Address issues of design, fabrication, and packaging issues of Microsystems.	3
CO5	Design of system models in application of advanced mechatronics system.	2

Mapping of Cos and POs

Course Out Comes	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO20.	1				1
CO21.	3				1
CO22.	3				1
CO23.	3				1
CO24.	1				2

Note:High-1,Medium–2,and Low – 3

DESIGN FOR MANUFACTURE AND ASSEMBLY			
Course Code	**22MMD243**	CIE Marks	50
Teaching Hours/Week(L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

1. To understand various general design rules for manufacturability and criteria for material selection
2. To study various machining process and tolerance aspects in machining.
3. To know the design considerations for casting, forging and welding process.
4. To study the general design guidelines for manual assembly and development of DFMA Methodology.

UNIT-1(8Hours)

Introduction to Design for Manufacture & Assembly: Steps in DFMA, Advantages of DFMA, Design guidelines for Manual Assembly and High-Speed Automatic and Robotic Assembly.
GeometricalDimensioning&Tolerance–Dimensions&Tolerance,Limits,FitsandTolerances,Holeand ShaftBasis,Threedatum–functional,machiningandmanufacturing,geometricalandformtolerance,conventional and advanced tools and techniques for measurements, numerical

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-2(8Hours)

Metal Casting Processes – Gravity Die Casting : compute the dimensions for Pattern, Mould, based on materialstobecast–ferrousandnon-ferrousalloys,influenceofpartingline,castholes,specialsandcores, shrinkagecompensation,numericals,**PressureDieCasting:**Diecastingalloys,machineselection,operation, sub-systems, post-processing equipments, mould design, number of cavities, manufacturing and assembly of moulds, design principles.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-3 (8Hours)

Design for Injection Molding – Injection moulding systems – injection subsystem, ejection system, clamping and feeding system, machine sizing, materials for injection moulding and its properties, injection mould design – cavity and core, manufacturing processes for moulds, operation and cycle time.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

UNIT-4(8Hours)

Design for Powder Metallurgy Processes: Introduction to PM process, blending and mixing, compaction, sinteringprocesses.Toolingmaterials,heattreatment,surfacetreatmentsandpreparationofgreencompacts, PresstoolsforPMprocess–load,toolinglayout,capacity;sinteringfurnaceandinfluenceofprocessand materials parameters on shrinkage.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments
UNIT-5(8Hours)	
Design for Sheet Metal Processing: Design of moulds for shearing, piercing, bending, deep drawing, progressive die operation, selection of press – hydraulic and electric, sub-systems, turret operation, cycle time calculation, laser cutting of sheet metals. **Cost Estimation** for sand casting, pressure die casting, injection moulding, PM process and sheet metal processes.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

Assessment Details (both CIE and SEE)

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Suggested Learning Resources:

Books

1. A.K. Chitale and R. C. Gupta, Product Design and Manufacturing, PHI 2007.
2. G.Boothroyd, P.Dewhurst and W.Knight, Product Design for Manufacture and Assembly, Marcell Dekker, 2002
3. R.Bryan , Fischer, Mechanical Tolerance stackup and analysis, Marcell Dekker, 2004.
4. M. F. Spotts, Dimensioning and Tolerance for Quantity Production, Prentice Hall Inc., 1999.

Sl.No	Description	Blooms Level
CO1	Explain the concept of DFMA and GD&NT.	3
CO2	Apply engineering products and suggest suitable manufacturing process.	3
CO3	Evaluate the influence of design, material and manufacturing processes on product assembly.	2
CO4	Develop appropriate manufacturing and assembly processes for a given product.	3
CO5	Analyze cost estimation of various metal processes.	2

Mapping of Cos and POs

Course Out Comes	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO25.	1				1
CO26.	3				1
CO27.	3				1
CO28.	3				1
CO29.	1				2

Note:High-1,Medium–2,and Low – 3

MINI PROJECT WITH SEMINAR			
Course Code	**22MMD25**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	0:4:2	SEE Marks	50
		Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini-Project with seminar: This may be hands-on practice, survey report, data collection and analysis, coding, mobile app development, field visit and report preparation, modelling of system, simulation, analyzing and authenticating, case studies, etc.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Students can present the seminar based on the completed mini-project. Participation in the seminar by all postgraduate students of the program shall be mandatory.

The CIE marks awarded for Mini-Project work and Seminar, shall be based on the evaluation of Mini Project work and Report, Presentation skill and performance in Question-and-Answer session in the ratio 50:25:25. Mini-Project with Seminar shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the Mini Project and Seminar shall be declared as fail in that course and have to complete the same during the subsequent semester.

There is no SEE for this course.

COURSE OUTCOMES:

At the end of the course the student will be able to:

• Present the mini-project and be able to defend it.
• Make links across different areas of knowledge and to generate, develop and evaluate ideas and information to apply
these skills to the project task.
• Habituated to critical thinking and use problem solving skills.
• Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
• Work in a team to achieve common goal.
• Learn on their own, reflect on their learning and take appropriate actions to improve it.

COURSE TITLE : DYNAMICS AND ANALYSIS LABORATORY		
Sub Code: 22MMDL26	**No of Credits : L-T-P-SS 1:0:2:0 = 2**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Design of machine elements**	

COURSE OBJECTIVES:

1. The main objective of this lab is to expose the student of mechanical engineering to various experimental techniques in order to prepare them for their professional career (Industrial and or R&D) The equipment's / instrumentation proposed are expected to provide the students a lot of insight into various experimental techniques in general and those connected with major mechanical systems in particular.
2. The experiment sequence is arranged in such a way to facilitate to introduce the students to engineering fundamentals, to develop their abilities to design experiments, and to motivate them to learn computer applications for data analysis

.

#	CONTENTS	h
UNIT-1	1. Experimental prediction of natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel with or without damping 2. Experimental prediction of natural frequencies, Torsional vibratory system, and comparison with theoretical results 3. Experimental and theoretical investigation of whirling of shaft (i.e. . comparison of experimental and theoretical natural frequency and justification of discrepancy between experiment and theory) 4.Determination of Fringe constant of Photo elastic material using (a) Circular disc subjected to diametric compression (b) Pure bending specimen (four point bending).(c) Tensile specimen. 6.Determination of stress concentration using Photo elasticity for simple components like circular disk with circular hole under diametrical compression, plate with a hole under tension or bending, 2D Crane hook.	**18**

UNIT-2	**Dynamic Analysis** a. Fixed- fixed beam for natural frequency Mode shape determination b. Bar subjected to forcing function c. Fixed- fixed beam subjected to forcing function d. Parametric analysis of natural frequency, damping ratio and mode shapes of cantilever beam condition using impact hammer	**08**

QUESTION PAPER PATTERN (SEE)

UNIT	**1**	**2**
Q. No.	**Q1**	**Q2**

SCHEME OF EXAMINATION (SEE)

Sl. No.	**Particulars**	**Max. Marks**	**Break Up of Max. Marks**		
			Write Up	**Conduction of experiment**	**Specimen Calculation, Tabulation of Results and Plotting of Graph if any**
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments and it is purely individual Experiment) Q1	**15**	05	05	05
2	**Unit-2: Major Experiment** (Any ONE **Experiment** from the list of experiments and it is a Group Experiment) Q2	**25**	05	10	10
3	Viva Voce	**10**	--	--	--
	TOTAL MARKS	**50**	**10**	**25**	**15**

- ❖ Two Full Questions to be set.
- ❖ Students shall be to be answered two full Questions.
- ❖ Each question(Experiments contains different Marks and it is clearly mentioned in the above table)
- ❖ Changing of Experiments is not allowed from any unite if changing of experiments allowed 50% marks will be deducted.
- ❖ Viva Voce is compulsory

REFERENCES TEXT BOOKS:

1. **Advanced Mechanics of solids**, L. S. Srinath, Tata Mc. Graw Hill, 2003
2. **Theory of Elasticity,** S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, 1972
3. **Theory of Elasticity,** Dr. Sadhu Singh, Khanna Publications, 1988
4. **Elasticity, Theory, Applications &Numericals,** Martin H Sadd, Elsevier. 2005
4. **Applied Elasticity,** Seetharamu & Govindaraju, Interline Publishing

COURSE OUTCOMES:

The major impact of the state of the art machine design lab is the exposure the students get to the modern experimental techniques and instrumentation. The experiments are planned in such a way that by the end of the course, the student is expected to have enough potential to design the experimentation as required at that point of time.

1.The major impact of the state of the art machine design lab is the exposure the students get to the modern experimental techniques and instrumentation.
2.Students will be able to understand the essence of kinetics and dynamics through experiments.
3. Students will be able to visualize the stresses developed in an object through photo elasticity implementation of concept of stress concentration in design.
4 The experiments are planned in such a way that by the end of the course, and the student has potential to design the experimentation as required at that point of time.

MAPPING OF COs WITH Pos

COs/POs	po1	po2	po3	po4	po5
CO1	3	3	3	2	2
CO2	2	3	3	2	2
CO3	3	3	3	2	3

CO4	3	3	2	2	3

- **High-3**
- **Medium-2**
- **Low-1**

COURSE TITLE: MOOC MASSIVE OPEN ONLINE COURSE- SELF STUDY		
Sub Code:22AUD27	**No of Credits : PP**	

GUIDELINES

Sl. No.	MOOC SUBJECT NAME
1.	Gas Dynamics and propulsion
2.	Nonlinear vibrations
3.	Modelling and control of Dynamic Electro Mechanical System
4.	Computer aided engineering design
5.	Kinematics of machines
6.	Finite Element Method: Variation Methods to Computer Programming
7.	Selection of Nanomaterials For Energy Harvesting And Storage Application
8.	Introduction to Mechanical Micro Machining
9.	Transport Phenomena in materials

- The student shall choose and register for any of the following NPTEL/SWAYAM core course amounting to 8 to 16 weeks.
- List of Massive Open Online Courses (NPTEL/SWAYAM) will be decided in the Board of Studies meeting.
- Students shall register for MOOC during 1st or 2nd semester and shall be completed before the last working day of the 2nd semester.
- The student shall choose a MOOC subject which is confined to his specialization and part of his final year thesis.
- The assignment and examination marks along with certificate should be submitted to the examination section.

9.	Transport Phenomena in materials

Dr. Ambedkar Institute of Technology

(An Autonomous Institute affiliated to VTU, Accredited by NAAC with 'A' grade)

Department of Mechanical Engineering

SCHEME OF TEACHING AND EXAMINATION III SEMESTER (Autonomous) 2022-23

M. Tech in Machine Design

III semester

Sl. No.	Course	Sub Code	Subject Title	Teaching hours per week			Maximum Marks allotted			Examination Credits
				Lecture	Practical / Project/ Seminar	Tutorial/ Skill Development Activity	CIE	SEE	Total	
1	PCC	22MMD31	Fracture Mechanics	3	-	2	50	50	100	**4**
2	PEC	22MMD32X	Professional Elective 3	3	-	-	50	50	100	**3**
3	OEC	22MMD33X	Open Elective Course – 1	3	-	-	50	50	100	**3**
4	PROJ	22MMDP34	Project work Phase-1	-	6	-	100	-	100	**3**
5	SP	22MMDS35	Societal Project	-	6	-	100	-	100	**3**
6	INT	22MMDI26	Internship	(6 Weeks internship to be completed during the intervening vacation of II & III Semester)			50	50	100	**6**
			Total	**09**	**12**	**02**	**400**	**200**	**600**	**22**

Note: **PCC**: Professional core courses, **PEC**: Professional Elective Courses, **IPCC**-Integrated Professional Core Courses. **MPS**-Mini Project With Seminar; **AUD/AEC**; Audit Courses / Ability Enhancement Courses (Mandatory), **PCCL**-Professional Core Course lab, **L**-Lecture, **P**-Practical, **T/SDA**-Tutorial / Skill Development Activities (Hours are for Interaction between faculty and students)

PROFESSIONAL ELECTIVE-3

Sl. No	Subject Code	Subject title
1	22MMD321	Mechanics Of Composite Materials
2	22MMD322	Sustainability Engineering
3	22MMD323	Rapid Prototyping
4	22MMD324	Theory Of Plasticity
5	22MMD325	Design Of Aerospace Structures

OPEN ELECTIVE-I

Sl. No	Subject Code	Name of the Subject
1	22MMD331	Design Automation With Iot
2	22MMD332	Reverse Engineering
3	22MMD333	Smart Materials
4	22MMD334	Optimization Through Matlab
5	22MMD335	Introduction To Hybrid And Electric Vehicles

Note:

1. Project Work Phase-1: The project work shall be carried out individually. However, in case a disciplinary or interdisciplinary project requires more participants, then a group consisting of not more than three shall be permitted. Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall pursue a literature survey and complete the preliminary requirements of the selected Project work. Each student shall prepare a relevant introductory project document, and present a seminar. CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

2. Societal Project: Students in consultation with the internal guide as well as with external guide (much preferable) shall involve in applying technology to workout/proposing viable solutions for societal problems. CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25. Those, who have not pursued /completed the Societal Project, shall be declared as fail in the course and have to complete the same during subsequent semester/s after satisfying the Societal Project requirements. There is no SEE (University examination) for this course.

3. Internship: Those, who have not pursued /completed the internship, shall be declared as fail in the internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms. CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

Dr. Ambedkar Institute of Technology

(An Autonomous Institute affiliated to VTU, Accredited by NAAC with 'A' grade)

Department of Mechanical Engineering

SCHEME OF TEACHING AND EXAMINATION IV SEMESTER (Autonomous) 2022-23

M. Tech in Machine Design

II semester

Sl. No.	Course	Sub Code	Subject Title	Teaching hours per week			Maximum Marks allotted			Examination Credits
				Lecture	Practical / Project/ Seminar	Tutorial/ Skill Development Activity	CIE	SEE	Total	
1	Project	22MMDP41	Project work Phase -2	-	8	-	100	100	200	**18**
			Total	**-**	**08**	**-**	**100**	**100**	**200**	**18**
	Grand Total (I to IV Semester) : 2100 Marks ; 80 Credits									

Note:

1. Project Work Phase-2:

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall continue to work of Project Work phase -1to complete the Project work. Each student / batch of students shall prepareproject document, and present a seminar. CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25. SEE shall be at the end of IVsemester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

Syllabus for 2022-23 Batch PG (MMD)

Semester: III	
Course Title: FRACTURE MECHANICS	
Course Code:**22MMD31**	CIE + Assignment + Group Activity + Seminar + SEE Marks = 30 + 10 + 5 + 5 + 50 = 100
Credits: 04 Course: PCC	
Hours: 52 Hrs. (L:T:P:S:4:0:0:0)	SEE Duration: 3 Hrs.

Course Learning Objectives:	
1	To discuss presence of various flaws in a body
2	To study different methods of identifying them non-destructively
3	To study the linear elastic fracture parameters such as Energy Release Rate and Stress Intensity Factor.
4	Discuss the elasto-plastic fracture parameters such as CTOD and J-Integral

UNIT – I	
Introduction to Fracture Mechanics: Kinds of Failure, Historical Aspects, Brittle and Ductile Fracture,Modes of Fracture Failure, How Potent is a Crack?, Point of View, Damage Tolerance. **Crack Detection through Non-Destructive Testing**: Examination through Human Senses, Liquid Penetration Inspection, Ultrasonic Testing, Radiographic Imaging, Magnetic Particle Inspection.	**12 Hrs**
UNIT – II	
Energy Release Rate: Griffith's Dilemma, Surface Energy, Griffith's Realization, Griffith's Analysis, Energy Release Rate, Energy Release Rate of DCB Specimen, Anelastic Deformation at Crack-tip, Crack Resistance, Stable and Unstable Crack Growth, R-curve for Brittle Cracks, Thin Plate vs Thick Plate, Critical Energy Release Rate.	**10 Hrs**
UNIT – III	
Stress Intensity Factor: Stress and Displacement Fields in Isotropic Elastic Materials ,Stress Intensity Factor, Background for Mathematical Analysis,Westergaard's Approach-Model (Opening Mode),Mode II (Sliding Mode),Mode III (Tearing Mode). **SIF of More Complex Cases**: Other Applications of Westergaard Approach, Application of the Principle of Superposition, Crack in a Plate of Finite Dimensions, Edge Cracks, Embedded Cracks, The Relation between GI and KI, Critical Stress Intensity Factor.	**10 Hrs**
UNIT – IV	
Anelastic Deformation at the Crack Tip:Further Investigation at the Crack Tip Approximate Shape and Size of the Plastic Zone,Effective Crack Length-Approximate Approach,The Irwin Plastic Zone Correction,Plastic Zone Size through the Dugdale Approach. Effect of Plate Thickness. **J-Integral**:Relevance and Scope,Definition of the J-Integral, Path Independence, Stress-Strain Relation, Further Discussion on J-Integral-From a Designer's Point of View, Experiments to Determine the Critical JIntegral,Comments on the Numerical Evaluation of J-Integral, Predicting Safety or Failure, Comments on the Experimental Determination of the Toughness of Ductile Materials.	**10 Hrs**
UNIT – V (Blended Learning)	
Crack Tip Opening Displacement: Introduction,Relationship between CTOD, KI and GI for Small Scale Yielding,Equivalence between CTOD and J. **Test Methods** :KIC-Test Technique, Test Methods to Determine JIC, Test Methods to Determine GIC and GIIC,Determination of Critical CTOD.	**10 Hrs**

Course Outcomes: The students will be able to

SL.NO	DESCRIPITION	BLOOMS LEVEL
CO1	Compute elastic stress analysis of cracked bodies subjected to various static loading and determine the expression for displacement, stress and strain.	3
CO2	Determine the expression for stress intensity factors for mode I mode II and Mode III loading.	2
CO3	Evaluate fracture Toughness for metallic materials according to ASTM standard Test methods	3
CO4	Identify the elastic plastic fracture behaviour and fracture toughness values in terms R, J, and CTOD.	2
CO5	Outline fatigue crack growth behaviour and crack growth laws and design mechanical members and develop fracture control plan.	5

Question paper pattern:
• The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub - questions) from each unit. • Each full question will have sub - question covering all the topics under a unit. • The students will have to answer five full questions, selecting one full question from each unit.

Text Books:	
1	Prashant Kumar, "Elements Of Fracture Mechanics", Tata McGraw-Hill Publishing Company Limited, 2009.
2	T. L. Anderson," Fracture Mechanics: Fundamentals and Applications,",3rd Edition. CRC Press, 2005.

Reference Books:	
1	Fatigue and Fracture Mechanics: 31st Volume by G Halford
2	Fatigue and Fracture Mechanics: v. 33 (Special Testing Publications) by Walter G Reuter and Robert S Piascik

CO/PO	PO1	PO2	PO3	PO4
CO1			1	1
CO2	1		1	1
CO3		1	1	
CO4	1	1		
CO5		1		1

Syllabus for 2022-23 Batch PG (MMD)

Semester: III	
Course Title: MECHANICS OF COMPOSITE MATERIALS	
Course Code:**22MMD321**	CIE + Assignment + Group Activity + Seminar + SEE Marks = 30 + 10 + 5 + 5 + 50 = 100
Credits: 03 Course: PEC	
Hours: 39 Hrs. (L:T:P:S:3:0:0:0)	SEE Duration: 3 Hrs.

Course Learning Objectives:	
1	Comprehend the basics of Composite Materials .
2	Select composite materials
3	Conduct stress and Stiffness analyses of Lamina and Laminate.
4	Use the theories of failure of composite materials under static loading

UNIT – I	
Introduction: Basic Concepts, Design Process, Composites Design Methods, Fracture Mechanics. **Materials**:Fiber Reinforcements, Fiber Types-Glass Fibers, Silica and Quartz Fibers, Carbon Fibers, Carbon Nanotubes, Organic Fibers, Boron Fibers, Ceramic Fibers, Basalt Fibers, Metallic Fibers, Natural Fibers; Fiber-Matrix Compatibility, Fiber Forms, Matrix Materials, Thermoset Matrices, Thermoplastic Matrices, Biodegradable Matrices, Creep, Temperature, and Moisture, Corrosion Resistance, Flammability	**10 Hrs**
UNIT – II	
Micromechanics: Basic Concepts Volume and Mass fraction, Heterogeneous Material, Anisotropic Material, Orthotropic Material, Transversely Isotropic Material, Isotropic Material; Stiffness-Longitudinal Modulus, Transverse Modulus, In-Plane Poisson's Ratio, In-Plane Shear Modulus, Intralaminar Shear Modulus, Restrictions on the Elastic Constants, **Strength** - Longitudinal Tensile Strength, Longitudinal Compressive Strength, Transverse Tensile Strength,Mode I Fracture Toughness, In-Plane Shear Strength, Mode II Fracture Toughness, Transverse Compressive Strength, Mohr-Coulomb Failure, Intralaminar Shear Strength.	**10 Hrs**
UNIT – III	
Ply Mechanics: Coordinate Systems, Stress and Strain, Stress-Strain Equations, Off-Axis Stiffness, Specially Orthotropic Lamina. **Macromechanics**: Plate Stiffness and Compliance, Computation of Stresses, Common Laminate Types, Laminate Moduli, Universal Carpet Plots.	**10 Hrs**
UNIT – IV	
Manufacturing Processes: Hand Layup, Prepreg Layup, Bag Molding, Autoclave Processing, Compression Molding, Resin Transfer Molding, Vacuum-Assisted Resin Transfer Molding, Pultrusion,Filament Winding, Textile Manufacturing.	**10 Hrs**
UNIT – V (Blended Learning)	
Ply Strength: Lamina Failure Criteria-Strength Ratio, Maximum Stress Criterion, Maximum Strain Criterion, Interacting Failure Criterion, First Ply Failure, Last Ply Failure, Laminate Strength.	**10 Hrs**

At the end of the course the student will be able to :

SL.NO	DESCRIPITION	BLOOMS LEVEL
CO1	Select Composite Materials based on the need of the situation	3
CO2	Design and analyse the lamina in its various orientations	3
CO3	Design and Analyse a composite laminate	3
CO4	Various Methods to manufacture a composite material.	2
CO5	To analyse plystrength of a composite material	5

Question paper pattern:
• The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub - questions) from each unit. • Each full question will have sub - question covering all the topics under a unit. • The students will have to answer five full questions, selecting one full question from each unit.

Text Books:	
1	Ever J. Barbero, "Introduction to Composite Materials Design", 3rd Edition, CRC Press, 2018
2	Autar K. Kaw," Mechanics of composite materials", CRC, 2nd Edition, Indian Print, 2009

Reference Books:	
1	Ever J. Barbero,"Introduction to Composite Materials Design" November 06, 2017
2	Edited By Rani Elhajjar, Valeria La Saponara, Anastasia Muliana,"Smart Composites: Mechanics and Design",1st Edition,October 23, 2017

CO/PO	PO1	PO2	PO3	PO4
CO1		1	1	
CO2	1	1		1
CO3		1	1	
CO4	1	1		
CO5		1		1

Syllabus for 2022-23 Batch PG (MMD)

Semester: III	
Course Title: SUSTAINABILITY ENGINEERING	
Course Code: **22MMD322**	CIE + Assignment + Group Activity + Seminar + SEE Marks = 30 + 10 + 5 + 5 + 50 = 100
Credits: 03 Course: PEC	
Hours: 50 (L:T:P:S:3:0:0:0)	SEE Duration: 3 Hrs

Course Learning Objectives:	
1	To have an increased awareness among students on issues in areas of sustainability
2	To understand the role of engineering and technology with sustainable development.
3	To know the methods, tools and incentives for sustainable products service system Development
4	To establish clear understanding of the role and impact t of various aspects of engineering decisions on environmental, societal and economic problems

UNIT – I	
Sustainability: Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development.	**10 Hrs**
UNIT – II	
Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climatechange, Ozone layer depletion, legal provisions for environmental protection.	**10 Hrs**
UNIT – III	
Environmental Management Standards: ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA)	**10 Hrs**
UNIT – IV	
Resources and its Utilisation: Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels.	**10 Hrs**
UNIT – V (Blended Learning)	
Sustainability Practices:Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanization, Sustainable cities, Sustainable transport	**10 Hrs**

Course Outcomes: The students will be able to	
1	Explain and apply yield criteria & flow
2	Design structures using fracture mechanics approaches
3	Apply principles of fracture mechanics
4	Solve problems related to plastic fracture mechanics

At the end of the course the student will be able to :

SL.NO	**DESCRIPITION**	**BLOOMS LEVEL**
CO1	Understand the relevance and the concept of sustainability and the global initiatives in this direction	2
CO2	Explain the different types of environmental pollution problems and their sustainable solutions	3
CO3	Discuss the environmental regulations and standards	2
CO4	Outline the concepts related to conventional and non-conventional energy	3
CO5	Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles	3

Question paper pattern:
• The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub - questions) from each unit. • Each full question will have sub - question covering all the topics under a unit. • The students will have to answer five full questions, selecting one full question from each unit.

Text Books	
1	Environmental Impact assessment guidelines, Notification of Govt of India, 2006.

Reference Books:	
1	Allen, D .T. and Shonnard, D .R., Sustainability Engineering: Concepts, Design and case studies, Prentice Hall
2	2. Bradley, A.S; Adebayo, A.O; Maria, P, Engineering applications in sustainable design and development, Cengage learning.
3	Mackenthun, K M; Basic concepts in Environmental management, Lewis publication, London 1998.
4	Ni bin Chang, Systems analysis for sustainable engg Theory and applications, Mcgraw Hill professional.

CO/PO	PO1	PO2	PO3	PO4
CO1	1	1	1	
CO2		1		1
CO3	1	1		
CO4	1		1	
CO5		1		1

Syllabus for 2022-23 Batch PG (MMD)

Semester: III	
Course Title: RAPID PROTOTYPING	
Course Code: **22MMD323**	CIE + Assignment + Group Activity + Seminar + SEE Marks = 30 + 10 + 5 + 5 + 100
Credits: 03 Course: PEC	
Hours: 39 Hrs. (L:T:P:S:3:0:0:0)	SEE Duration: 3 Hrs.

Course Learning Objectives:	
1	Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications
2	Applying of measurement and scaling technique for prototype manufacturing.
3	Identify The process photopolymers, photo polymerization, layering technology, laser and laser scanning

UNIT – I	
Introduction: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems.	**10 Hrs**
UNIT – II	
Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application, Selective Laser Sintering and Fusion Deposition **Modeling**:Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Principle of Fusion deposition modeling, Process parameter, , Applications.	**10 Hrs**
UNIT – III	
Solid Ground Curing: Principle of operation, Machine details, Applications. Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.	**10Hrs**
UNIT – IV	
Rapid Tooling: Indirect Rapid tooling -Silicone rubber tooling – Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3Q keltool.	**10 Hrs**
UNIT – V (Blended Learning)	
Direct Rapid Tooling Direct: AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling.	**10 Hrs**

At the end of the course the student will be able to :

SL.NO	DESCRIPITION	BLOOMS LEVEL
CO1	Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications.	2
CO2	Explain direct metal laser sintering, LOM and fusion deposition modelling processes.	2
CO3	Demonstrate solid ground curing principle and process.	3
CO4	Discuss LENS, BPM processes; point out the application of RP system in medical field define virtual prototyping and identify simulation components.	2
CO5	Understand the RP Process Optimizations.	3

Question paper pattern:
• The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub - questions) from each unit. • Each full question will have sub - question covering all the topics under a unit. • The students will have to answer five full questions, selecting one full question from each unit.

Text Books:	
1	Paul F. Jacobs ,"Stereolithography and other RP&M technologies- from rapid prototyping to rapid tooling", - Dearborn, Mich. : Society of Manufacturing Engineers in cooperation with the Rapid Prototyping Association of SME ; New York : ASME Press .1996
2	Rapid Manufacturing - Flham D.T &Dinjoy S.S - Verlog London2001.

Reference Books:	
1	3. Rapid automated - Lament wood - Indus press NewYork (4)Wohler's Report 2000 - Terry Wohlers - Wohler's Association -2000

CO/PO	PO1	PO2	PO3	PO4
CO1		1	1	
CO2	1	1		
CO3	1			1
CO4		1		1
CO5	1		1	

Syllabus for 2022-23 Batch PG (MMD)

Semester: III	
Course Title: THEORY OF PLASTICITY	
Course Code: **22MMD324**	CIE + Assignment + Group Activity + Seminar + SEE Marks = 30 + 10 + 5 + 5 + 50 = 100
Credits: 03 Course: PEC	
Hours: 39 Hrs. (L:T:P:S:3:0:0:0)	SEE Duration: 3 Hrs.

Course Learning Objectives:	
1	To learn principles of Bridge Design,
2	To design different types of structures and to detail the structures.
3	To evaluate performance of the Bridge structures.

UNIT – I	
Elasticity: Two dimensional stress analysis – Plane stress – Plane strain – Equations of compatibility – Stress function – Boundary conditions. Problem in Rectangular Coordinates – Solution by polynomials – Saint Venent's principles – Determination of displacement – Simple beam problems. Problems in Polar Coordinates – General equations in polar coordinates – Stress distribution symmetrical about axis – Strain components in polar coordinates – Simple and symmetric problems.	**10 Hrs**
UNIT – II	
Analysis of Stress and Strain in Three Dimensions: Principle stresses – Homogeneous deformations – Strain spherical and deviatoric stress – Hydrostatic strain. General theorems: Differential equations of equilibrium and compatibility – Displacement – Uniqueness of solution – Reciprocal theorem.	**10 Hrs**
UNIT – III	
Bending of Prismatic Bars: Stress function – Bending of cantilever beam – Beam of rectangular cross-section – Beams of circular cross-section.	**10 Hrs**
UNIT – IV	
Plasticity: Plastic deformation of metals – Structure of metals – Deformation – Creep stress relaxation of deformation – Strain rate condition of constant maximum shear stress – Condition of constant strain energy – Approximate equation of plasticity.	**10 Hrs**
UNIT – V (Blended Learning)	
Methods of Solving Practical Problems: The characteristic method – Engineering method – Compression of metal under press – Theoretical and experimental data drawing.	**10 Hrs**

At the end of the course the student will be able to :

SL.NO	DESCRIPITION	BLOOMS LEVEL
CO1	Understand the basic concepts of fundamental variables such as stress, strain, and Displacement under the application of load, strain-rate, strain-hardening	2
CO2	Recognize typical plastic yield criteria established in constitutive modeling	3
CO3	Apply basic analytical equations and constitutive models in the analysis of structures Subjected to plastic deformation.	3
CO4	Use the principles of plasticity to analyze axisymmetric elastic-plastic problems of Practical importance and indentation problem	3
CO5	Understand the principles of new autofrettage techniques such as thermal autofrettage .	3

Question paper pattern:
• The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub - questions) from each unit. • Each full question will have sub - question covering all the topics under a unit. • The students will have to answer five full questions, selecting one full question from each unit.

Text Books:	
1	"Theory of Elasticity",Timoshenko S.P. and Goodier,J.N.Koakusha Publishers
2	An Engineering Theory of Plasticity/E.P. Unksov/Butterworths
3	Theory of Plasticity for Engineers/Hoffman and Sacks/TMH

Reference Books:	
1	Theory of Elasticity and Plasticity/Sadhu Singh/ Khanna Publishers
2	Theory of Elasticity and Plasticity/Harold Malcolm Westergaard/Harvard University Press

CO/PO	PO1	PO2	PO3	PO4
CO1	1		1	
CO2	1	1		
CO3	1			1
CO4	1		1	
CO5		1	1	

Syllabus for 2022-23 Batch PG (MMD)

Semester: III	
Course Title: DESIGN OF AEROSPACE STRUCTURES	
Course Code: **22MMD325**	CIE + Assignment + Group Activity + Seminar + SEE Marks = 30 + 10 + 5 + 5 + 50 = 100
Credits: 03 Course: PEC	
Hours: 39 Hrs. (L:T:P:S:3:0:0:0)	SEE Duration: 3 Hrs.

Course Learning Objectives:	
1	To study basic concepts of aircraft structures & materials, and various types of loads acting on an aircraft.
2	To understand concepts of open and closed thin walled beams.
3	To acquire the knowledge of buckling of plates, joints and fittings.
4	Comprehend the stress analysis on wings and fuselage.

UNIT – I	
Loads on Aircraft and Aircraft Materials: Structural nomenclature, Types of loads,Load factor, Aerodynamics loads, Symmetric manoeuvre loads, Velocity diagram, Function of structural components. **Aircraft Materials**: Metallic and non-metallic materials, Use of Aluminum alloy, titanium, stainless steel and composite materials. Desirable properties for aircraft application	**10 Hrs**
UNIT – II	
Bending of Open and Closed Thin Walled Beams: Symmetrical bending, unsymmetrical bending, direct stress distribution due to bending, position of the neutral axis, load intensity, shear force, and bending moment relationships, deflection due to bending,calculation of section properties, approximation for thin-walled sections.	**10 Hrs**
UNIT – III	
Shear and Torsion of Open and Closed Thin Walled Beams: General stress, strain, and displacement relationship for open and single-cell closed section thin-walled beams, shear of open section beams, shear centre, shear of closed section beams. Torsion of close section beam, and displacement associated with the Bredt-Batho shear flow. Torsion of open section beam.Combined bending, shear, torsion.	**10 Hrs**
UNIT – IV	
Forms of light gauge sections, Effective width computation of unstiffened, stiffened, multiple stiffened compression elements of cold formed light gauge sections. Concept of local buckling of thin elements. Limiting width to thickness ratio. Post buckling strength.	**10 Hrs**
UNIT – V (Blended Learning)	
Stress Analysis in Wing Spars and Box beams: Tapered wing spar, open and closed section beams, beams having variable stringer areas, three- boom shell, torsion and shear, tapered wings, cut-outs in wings. Stress Analysis in Fuselage Frames: Bending, shear, torsion, cut-outs in fuselages, principles of stiffeners construction, fuselage frames, shear flow distribution.	**10 Hrs**

At the end of the course the student will be able to:

SL.NO	DESCRIPITION	BLOOMS LEVEL
CO1	Understand the various loads acting on aircraft.	2
CO2	Understand various types of materials used in aircraft configuration.	2
CO3	Apply the concept of thin walled beams.	3
CO4	Calculate the buckling of plates.	3
CO5	Analyze the stresses in wings and fuselage structures / frames.	4

Question paper pattern:
• The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub - questions) from each unit. • Each full question will have sub - question covering all the topics under a unit. • The students will have to answer five full questions, selecting one full question from each unit.

Text Books:	
1	Megson, T. H. G., "Aircraft Structures for Engineering Students", Edward Arnold, 1995, ISBN-10:
2	Peery D J & Azar J J, "Aircraft Structures", McGraw Hill N.Y, 2nd edition,1993, :

Reference Books:	
1	Bruhn E. F, "Analysis & Design of Flight Vehicles Structures", Tri-State offset Co, USA, 1985, ISBN10

CO/PO	PO1	PO2	PO3	PO4
CO1	1	1		
CO2		1		1
CO3	1		1	
CO4		1		1
CO5	1			1

Syllabus for 2022-23 Batch PG (MMD)

Semester: III	
Course Title: DESIGN AUTOMATION WITH IoT	
Course Code: **22MMD331**	CIE + Assignment + Group Activity + Seminar + SEE Marks = 30 + 10 + 5 + 5 + 50 = 100
Credits: 03 Course: OEC	
Hours:50 Hrs. (L:T:P:S:3:0:0:0)	SEE Duration: 3 Hrs.

Course Learning Objectives:	
1	To introduce students to the field of IoT
2	To familiarise students different types of sensors used in automation.
3	To provide awareness about the applications of IoT

UNIT – I	
Introduction: Introduction to IoT & Cyber-Physical Systems, IoT Enabling Technologies– Physical End points,Network Services, Cloud. Different Levels of IoT Applications.	**10 Hrs**
UNIT – II	
Communication and networking technologies in IoT: Communication models, AdHoc. Industrial & Automotive Networks, Vehicular networks.	**10 Hrs**
UNIT – III	
Thermo resistive Sensors- Thermistors, Resistance Temperature Sensors, and Silicon Resistive Sensors, Thermo electric sensors, PN junction temperature sensors, thermos mechanical sensors and actuators. Photoelectric sensors, optical actuators.	**10 Hrs**
UNIT – IV	
Mechanical Sensors and Actuators- force sensors, pressure sensors, Acoustic actuators, ultrasonic sensors and actuators. MEMS and Smart sensors- pressure sensors, thermal and piezo electric actuation, wireless sensors and actuators.	**10 Hrs**
UNIT – V (Blended Learning)	
IoT implementation: Transportation and logistics, Energy and utilities, Automotive Connected supply chain, Plant floor control automation, remote monitoring. **Applications HCI and IoT world** -Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy, Smart factories, Future research Challenges.	**10 Hrs**

At the end of the course the student will be able to:

SL.NO	DESCRIPITION	BLOOMS LEVEL
CO1	Understand the principles of manufacturability and design for manufacture	2
CO2	Design casting for economic production.	3
CO3	Understand the concept of easy assembly, based on rules of DFMA to reduce the time of assembly	2
CO4	Redesign the parts for easy manufacturing based on rules of DFMA to reduce the time of manufacturing and enhance cost effectiveness.	3
CO5	Design guidelines and background for powder metallurgy parts and reviewing of formed parts.	4

Question paper pattern:
• The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub - questions) from each unit. • Each full question will have sub - question covering all the topics under a unit. • The students will have to answer five full questions, selecting one full question from each unit.

Text Books:	
1	Adrian McEwan and Hakim Cassimally, "Designing the internet of things", Wiley, 2013
2	Vijay Madisetti and Arshdeep Bahga,"Internet of Things (A Hands-on-Approach)",1st Edition,VPT, 2014.
3	N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.

Reference Books:	
1	Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies & Sensors for the Internet of Things Businesses & Market Trends 2014 - 2024',YoleDéveloppement Copyrights ,2014
2	Boyle, "From Machine-to-Machine to the Internet of Things -Introduction to a New Ageo Intelligence" Elsevier

CO/PO	PO1	PO2	PO3	PO4
CO1		1	1	
CO2	1		1	
CO3		1		1
CO4	1	1		
CO5		1		1

Syllabus for 2022-23 Batch PG (MMD)

Semester: III	
Course Title: REVERSE ENGINEERING	
Course Code: **22MMD332**	CIE + Assignment + Group Activity + Seminar + SEE Marks = 30 + 10 + 5 + 5 + 50 = 100
Credits: 03 Course: OEC	
Hours: 50 Hrs. (L:T:P:S:3:0:0:0)	SEE Duration: 3 Hrs.

Course Learning Objectives:	
1	Understand basic engineering systems.
2	Understand the terminologies related to re-engineering, forward engineering, and reverse engineering.
3	Understand Reverse Engineering methodologies.
4	Understand Reverse engineering of Systems, Mechanical RE, Electronic RE, and Computer RE

UNIT – I	
Introduction to Reverse Engineering: Introduction, What Is Reverse Engineering?, Why Use Reverse Engineering?, Reverse Engineering–The Generic Process, Phase 1–Scanning, Phase 2–Point Processing, Phase 3–Application Geometric Model Development. **Methodologies and Techniques for Reverse Engineering**: Computer-aided Reverse Engineering, Computer Vision and Reverse Engineering, Structured-light Range Imaging, Scanner Pipeline.	**10 Hrs**
UNIT – II	
Reverse Engineering–Hardware and Software: Introduction, Reverse Engineering Hardware, Reverse Engineering Software. **Selecting a Reverse Engineering System**: The Selection Process, Some Additional Complexities, PointCapture Devices, Triangulation Approaches, "Time-of-flight" or Ranging Systems, Structured-light and Stereoscopic Imaging Systems, Issues with Light-based Approaches, Tracking Systems, Internal Measurement Systems, Destructive Systems, Some Comments on Accuracy, Positioning the Probe, Postprocessing the Captured Data, Handling Data Points, Curve and Surface Creation, Inspection Applications, Manufacturing Approaches.	**10 Hrs**
UNIT – III	
Introduction to Rapid Prototyping: The Basic Process, Current Techniques and Materials, Applications, Future. **Relationship Between Reverse Engineering and Rapid Prototyping**: Introduction, The Adaptive Slicing Approach for Cloud Data Modeling, Planar Polygon Curve Construction for a Layer,Determination of Adaptive Layer Thickness, Some Application Examples.	**10 Hrs**
UNIT – IV	
Reverse Engineering in the Automotive Industry: Introduction, Reverse Engineering– Workflow for Automotive Body Design, Reverse Engineering for Better Quality, A Look Ahead–Convergence of Digital and Physical Worlds. **Reverse Engineering in the Aerospace Industry**:Introduction,RE in Aerospace–A Work in Progress,Reducing Costs of Hard Tooling,Inspection in Half the Time,Making the Next Great Leap	**10 Hrs**
UNIT – V (Blended Learning)	
Reverse Engineering in the Medical Device Industry:Introduction,Orthodontics Without Wires and Brackets,Improving the Scanning Process,The Six-stage Process,Achievement,Digital Dentistry Becomes Reality,Hearing Instruments Meet the Digital Age,Reverse Engineering–A Better Knee Replacement,The Quest for a Total Artificial Heart,Moving Toward Mass Customization. **Barriers to Adopting Reverse Engineering**:Background,The Research Model,Research Methodology,Factor Analysis Approach,Findings. **Legal Aspects of Reverse Engineering**:Introduction,Copyright Law,Reverse Engineering,Recent Case Law.	**10 Hrs**

At the end of the course the student will be able to:

SL.NO	DESCRIPITION	BLOOMS LEVEL
CO1	Understand the Reverse Engineering (RE) Methodology	4
CO2	Disassemble products and specify the interactions between its subsystems and their functionality	2
CO3	Understand Computer-Aided RE and Rapid Prototyping Technology	3
CO4	Experiments with open-source software used in RE	2
CO5	Application and barriers of RE in medical industry	2

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub – questions) from each unit.
- Each full question will have sub – question covering all the topics under a unit.
- The students will have to answer five full questions, selecting one full question from each unit.

Text Books:

1	Vinesh Raja and Kiran J. Fernandes (Eds.)," Reverse Engineering : an industrial perspective.", Springer series in advanced Manufacturing, Springer-Verlag London Limited 2008. .

Reference Books:

1	Wego Wang,Reverse Engineering Technology of Reinvention,CRC Press, 2011

CO/PO	PO1	PO2	PO3	PO4
CO1		1		1
CO2	1	1		
CO3	1		1	
CO4	1	1		
CO5			1	1

Syllabus for 2022-23 Batch PG (MMD)

Semester: III	
Course Title: SMART MATERIALS AND STRUCTURES	
Course Code: **22MMD333**	CIE + Assignment + Group Activity + Seminar + SEE Marks = 30 + 10 + 5 + 5 + 50 = 100
Credits: 03 Course: OEC	
Hours: 39 Hrs. (L:T:P:S:3:0:0:0)	SEE Duration: 3 Hrs.

Course Learning Objectives:	
1	To make students to investigate the cause of deterioration of concrete structures.
2	To identify different repair and rehabilitation of structures.
3	To evaluate the performance of the materials for repair.

UNIT – I	
Smart Structures: Types of Smart Structures, Potential Feasibility of Smart Structures, Key Elements Of Smart Structures, Applications of Smart Structures. Piezoelectric materials, Properties, piezoelectric Constitutive Relations, Depoling and Coersive Field, field strain relation. Hysteresis, Creep and Strain Rate effects, Inchworm Linear Motor. **Beam Modeling**: Beam Modeling with induced strain Rate effects, Inchworm Linear Motor Beam Modeling with induced strain Actuation-single Actuators, dual Actuators, Pure Extension, Pure Bending harmonic excitation, Bernoulli-Euler beam Model, problems, Piezoelectrical Applications.	**10 Hrs**
UNIT – II	
Shape memory Alloy: Experimental Phenomenology, Shape Memory Effect, Phase Transformation, Tanaka's Constitutive Model, testing of SMA Wires, Vibration Control through SMA, Multiplexing. Applications Of SMA and Problems. **ER and MR Fluids**: Mechanisms and properties, Fluid Composition and behavior, The Bingham Plastic and Related Models, Pre-Yield Response.Post-Yield flow applications in Clatches, Dampers and Others.	**10 Hrs**
UNIT – III	
Vibration Absorbers: series and Parallel Damped Vibrations (OverView), Active Vibration Absorbers, Fiber Optics, Physical Phenomena,Characteristics, Sensors, Fiber Optics in Crack Detection, applications. **Control of Structures**: Modeling, Control Strategies and Limitations, Active Structures in Practice.	**10 Hrs**
UNIT – IV	
Mechanical Properties of MEMS Materials: Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration.	**10 Hrs**
UNIT – V (Blended Learning)	
Devices: Sensors and Actuators, Conductivity of Semiconductors, Crystal Planes and Orientation, (Stress and Strain Relations, Flexural Beam Bending Analysis Under Simple Loading Conditions), Polymers in MEMS, Optical MEMS Applications**.**	**10 Hrs**

At the end of the course the student will be able to:

SL.NO	DESCRIPITION	BLOOMS LEVEL
CO1	Understand the behaviour and applicability of various smart materials	2
CO2	Design simple models for smart structures & materials.	3
CO3	Perform simulations of smart structures & materials application	2
CO4	Conduct experiments to verify the predictions	3
CO5	Applications of MEMS in various fields	2

Question paper pattern:
• The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub - questions) from each unit. • Each full question will have sub - question covering all the topics under a unit. • The students will have to answer five full questions, selecting one full question from each unit.

Text Books:	
1	Electroceramics: Materials, Properties and Applications - A. J. Moulson and J. M. Herbert. John Wiley & Sons, ISBN:0471497429 .
2	Piezoelectric Sensories: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer,Berlin; New York, 2002 (ISBN: 3540422595).
3	Piezoelectric Actuators and Wtrasonic Motors - K. Uchino, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).

Reference Books:	
1	Handbook of Giant Magnetostrictive Materials - G. Engdahl, Academic Press, San Diego, Calif.; London, 2000 (ISBN:012238640X).
2	5. Shape Memory Materials - K. Otsuka and C. M. Wayman, Cambridge University Press, Cambridge; New York, 199~ (ISBN:052144487X).

CO/PO	PO1	PO2	PO3	PO4
CO1	1	1		
CO2		1	1	
CO3	1	1		
C04	1		1	
CO5		1		1

Syllabus for 2022-23 Batch PG (MMD)

Semester: III	
Course Title: BASIC CONSTRUCTION MATERIALS	
Course Code: **22MMD334**	CIE + Assignment + Group Activity + Seminar + SEE Marks = 30 + 10 + 5 + 5 + 50 = 100
Credits: 03 Course: OEC	
Hours: 39 Hrs. (L:T:P:S:3:0:0:0)	SEE Duration: 3 Hrs.

Course Learning Objectives:	
1	To understand basic engineering optimization techniques and their applications.
2	To introduce the mathematical preliminaries required for optimization.
3	To understand basic linear and nonlinear programming techniques.
4	To understand various MATLAB programs for solving linear & nonlinear programming problems, multi-objective optimization problems, and integer programming problems.

UNIT – I	
Introduction: Introduction, historical development, engineering applications of optimization, statement of an optimization problem, classification of optimization problems, optimization techniques. Solution of optimization problem using MATLAB. **Mathematical Preliminaries**: Overview, vectors and geometry – dot product, equation of a line, equation of a plane; basic linear algebra: preliminary definitions, matrix operations, determinants, inverse, eigenvalues, eigenvectors, positive definiteness; basic calculus: types of functions, derivative, integration and taylor series; optimization basics	**10 Hrs**
UNIT – II	
Linear Programming: Overview, basics of linear programming (LP), single objective optimization, solution approaches: analytical, numerical, experimental and graphical. **Simplex Methods**: Standard form, Gauss Jordan elimination, reducing to row echelon form, the basic solution; duality; simplex algorithm. Solving LP problems using MATLAB.	**10 Hrs**
UNIT – III	
Nonlinear Programming with No Constraints: Overview, necessary and sufficient conditions, single variable optimization, multivariable optimization. MATLAB solutions. **Nonlinear Programming with Constraints**: Overview, structure of constrained optimization, elimination method, penalty methods, Karush-Kuhn-Tucker conditions, sequential linear programming, sequential quadratic programming. MATLAB solutions.	**10 Hrs**
UNIT – IV	
Multiobjective Optimization: Overview, the multiobjective problem definition, pareto optimal solution, the weighted sum method, compromise programming, generating the pareto frontier with MATLAB, reaching a target - goal programming, expressing a preference – physical programming. Multiobjective optimization using MATLAB optimization toolbox. **Physical Programming for Multiobjective Optimization**: Overview, linear physical programming (LPP), nonlinear physical programming (NPP), comparison of LPP with goal programming.	**10 Hrs**
UNIT – V (Blended Learning)	
Integer Programming: Introduction, integer linear programming – graphical representatio Gomory's cutting plane method; integer nonlinear programming – integer polynomial programmin branch-andbound method, sequential linear discrete programming, generalized penalty functio method. Solution of binary programming problem using MATLAB.	**10 Hrs**

At the end of the course the student will be able to:

SL.NO	DESCRIPITION	BLOOMS LEVEL
CO1	Define optimization terminology &concepts, and classify an optimization problem.	2
CO2	Understand basic mathematical concepts needed for solving optimization problems.	3
CO3	Apply mathematical concepts and optimization techniques to solve linear & nonlinear programming problems, multiobjective optimization problems, and integer programming problems.	3
CO4	Solve linear & nonlinear programming problems, multiobjective optimization problems, and integer programming problems using MATLAB.	3
CO5	Solution of binary programming problem using MATLAB.	3

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub - questions) from each unit.
- Each full question will have sub - question covering all the topics under a unit.
- The students will have to answer five full questions, selecting one full question from each unit.

Text Books:

1. S.S. Rao, "Engineering Optimization – Theory and Practice", 4th edition, John Wiley & Sons, Inc., 2009, ISBN 978-0-470-18352-6.

Reference Books:

1. Achille Messac, "Optimization in Practice with MATLAB", Cambridge University Press, 2015, ISBN 978-1-107-10918-6.

CO/PO	PO1	PO2	PO3	PO4
CO1	1	1		
CO2		1	1	
CO3		1	1	
CO4		1	1	
CO5		1	1	

Syllabus for 2022-23 Batch PG (MMD)

Semester: III	
Course Title: INTRODUCTION TO HYBRID AND ELECTRIC VEHICLES	
Course Code: **22MMD335**	CIE + Assignment + Group Activity + Seminar + SEE Marks = 30 + 10 + 5 + 5 + 50 = 100
Credits: 03 Course: OEC	
Hours: 39 Hrs. (L:T:P:S:3:0:0:0)	SEE Duration: 3 Hrs.

Course Learning Objectives:	
1	Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
2	Analyze various electric drives suitable for hybrid electric vehicles
3	Discuss different energy storage technologies used for hybrid electric vehicles and their control.
4	Demonstrate different configurations of electric vehicles and its components, hybrid vehicle configuration by different techniques, sizing of components and design optimization and energy management.

UNIT – I	
Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. **Conventional Vehicles**: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.	**8 Hrs**
UNIT – II	
Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. **Electric Drive-trains**: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.	**8 Hrs**
UNIT – III	
Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency. **Energy Storage**: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.	**8 Hrs**
UNIT – IV	
Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems 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, implementation issues of energy management strategies.	**8 Hrs**
UNIT – V (Blended Learning)	
Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicl (BEV).	**7 Hrs**

At the end of the course the student will be able to:

SL.NO	DESCRIPITION	BLOOMS LEVEL
CO1	Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.	1
CO2	Explain the use of different energy storage devices used for hybrid electric vehicles, theirtechnologies and control and select appropriate technology	2
CO3	Interpret working of different configurations of electric vehicles and its components, hybridvehicle configuration.	4
CO4	performance analysis and Energy Management strategies in HEVs.	3
CO5	Case studies of HEV & BEV.	4

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub - questions) from each unit.
- Each full question will have sub - question covering all the topics under a unit.
- The students will have to answer five full questions, selecting one full question from each unit.

Text Books:

1	Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

Reference Books:

1	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

CO/PO	PO1	PO2	PO3	PO4
CO1	1			
CO2	1	1		
CO3			1	1
CO4		1	1	
CO5			1	1

Syllabus for 2022-23 Batch PG (MMD)

Semester: III	
Course Title: Project Work Phase – I(Presentation of Synopsis)	
Course Code: **22MMDP34**	CIE = 100 Marks
Credits: 03 Course: PROJ	
Hours: 39 Hrs. (L:T:P:S:0:0:6:0)	

Course Learning Objectives:	
1	To improve the professional competency and research aptitude by touching the specific areas which otherwise not covered by theory or laboratory classes.
2	The project work aims to develop the work practice in students to apply theoretical and practical tools / techniques to solve real life problems related to industry/field and current research.

The project work can be analysis and design projects of innovative nature or experimental investigation or numerical simulations or a combination of these. Appropriate software developments with sufficient literature contributions can also be taken up. Each student will be allotted with a faculty as guide. In specific cases student may consult with an external guide with the prior consents of internal guide and head of the department. In this semester, students are expected to finalize appropriate topic of research, complete the required literature survey and objectives of their intended research.

Note:
Phase – I evaluation on the basis of students progress.

Reading Materials	
1	Journal Publication.
2	Conference / Seminar Proceedings.
3	Handbooks / Research Digests / Codebooks.

At the end of the course the student will be able to:

SL.NO	DESCRIPITION	BLOOMS LEVEL
CO1	Demonstrate a sound technical knowledge of their selected project topic	1
CO2	Undertake problem identification, formulation, and solution.	2
CO3	Design engineering solutions to complex problems utilising a systems approach.	4
CO4	Communicate with engineers and the community at large in written an oral forms.	3
CO5	Demonstrate the knowledge, skills and attitudes of a professional engineer.	4

CO/PO	PO1	PO2	PO3	PO4
CO1	1		1	
CO2		1	1	1
CO3	1	1		1

Syllabus for 2022-23 Batch PG (MMD)

Semester: III	
Course Title: SOCIETAL PROJECT	
Course Code: **22MMDS35**	CIE = 100 Marks
Credits: 03 Course: SP	
Hours: 39 Hrs. (L:T:P:S:0:0:6:0)	

Course Learning Objectives:	
1	To improve the professional competency and research aptitude by touching the specific areas which otherwise not covered by theory or laboratory classes.
2	The project work aims to develop the work practice in students to apply theoretical and practical tools / techniques to solve real life problems related to industry/field and current research.

Students in consultation with the internal guide as well as with external guide (much preferable) shall involve in applying technology to workout/proposing viable solutions for societal problems. CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session. Those, who have not pursued /completed the Societal Project, shall be declared as fail in the course and have to complete the same during subsequent semester/s after satisfying the Societal Project requirements. There is no SEE for this course.

Reading Materials	
1	Journal Publication.
2	Conference / Seminar Proceedings.
3	Handbooks / Research Digests / Codebooks.

SL.NO	DESCRIPITION	BLOOMS LEVEL
CO1	Identify and chose appropriate topic of relevance.	1
CO2	Critically evaluate literature in chosen area of research & Establish Scope of work.	2
CO3	Define Research Problem Statement.	4
CO4	Communicate with engineers and the community at large in written an oral forms.	3
CO5	Demonstrate the knowledge, skills and attitudes of a professional engineer.	4

CO/PO	PO1	PO2	PO3	PO4
CO1	1		1	
CO2		1	1	1
CO3	1	1		1
CO4	1		1	
CO5		1	1	1

Syllabus for 2022-23 Batch PG (MMD)

Semester: III	
Course Title: INTERNSHIP	
Course Code: **22MMDI36**	CIE + SEE Marks = 50 + 50
Credits:06 Course: INT	
Hours: 52Hrs (L:T:P:S:0:0:16:0)	SEE Duration: 3 Hrs

Course Learning Objectives:	
1	Ability to expose to a particular job and a profession or industry.
2	Explore career alternatives prior to graduation.
3	Develop business skills in communication, technology and team work.

The students are informed to select a suitable company to carry out Internship in their respective field of specialization. The student shall make a midterm presentation of the activities undertaken during the internship course to the panel comprising Internship Guide, a senior faculty from the department and Head of the Department. The Department shall facilitate and monitor the student internship program. ***The internship report of each student shall be submitted to the Institute.**

Note:
6 Weeks internship to be completed during the intervening vacation of II & III Semester

SL.NO	DESCRIPITION	BLOOMS LEVEL
CO1	Develop work culture in groups.	2
CO2	Identify and demonstrate work habits for success in real field.	2
CO3	Develop network of the various contacts to exhibit work efficiency through presentations, reports, group discussions to the public.	3
CO4	Communicate with engineers and the community at large in written an oral forms.	1
CO5	Demonstrate the knowledge, skills and attitudes of a professional engineer.	2

CO/PO	PO1	PO2	PO3	PO4
CO1	1	1		
CO2	1	1		
CO3		1	1	
CO4	1	1		
C05	1	1		

Syllabus for 2022-23 Batch PG (MMD)

Semester: IV	
Course Title: EVALUATION OF PROJECT PHASE 2	
Course Code: **22MMDP41**	CIE + SEE Marks = 100 + 100 Marks
Credits: 18 Course: PROJ	
Hours: 52 Hrs. (L:T:P:S:0:0:8:0)	SEE Duration: 3 Hrs

Course Learning Objectives:	
1	To improve the professional competency and research aptitude by touching the specific areas which otherwise not covered by theory or laboratory classes.
2	The project work aims to develop the work practice in students to apply theoretical and practical tools / techniques to solve real life problems related to industry/field and current research.

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall continue to work of Project Work phase -1to complete the Project work. Each student / batch of students shall prepare project document, and present a seminar. CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session. SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

Reading Materials	
1	Journal Publication.
2	Conference / Seminar Proceedings.
3	Handbooks / Research Digests / Codebooks.

SL.NO	DESCRIPITION	BLOOMS LEVEL
CO1	Critically evaluate literature in chosen area of research & work in accordance to the Scope.	2
CO2	Conduct experiments/ design exclusively.	3
CO3	Arrive at conclusion and define future scope for work.	2
CO4	evaluate in chosen area of research & work in accordance to the Scope.	3
CO5	Demonstrate the knowledge, skills and attitudes of a professional engineer.	3

Course Outcomes: The students will be able to	
1	Critically evaluate literature in chosen area of research & work in accordance to the Scope.
2	Conduct experiments/ design exclusively.
3	Arrive at conclusion and define future scope for work.

CO/PO	PO1	PO2	PO3	PO4
CO1	1	1		
CO2		1	1	
CO3	1	1		
CO4		1	1	
CO5		1	1	