Course Curriculum

For

M. Tech. (Mechanical Engineering)
Specialization: CAD/CAM

Department of Mechanical Engineering
National Institute of Technology Delhi

w.e.f. the Academic Year
2022-2023

Department of Mechanical Engineering
National Institute of Technology Delhi

1.1 About the Department

Welcome to the Department of Mechanical Engineering at NIT Delhi. Mechanical Engineering is a diverse field, which involves design, analysis and manufacturing from small machine parts and devices to large systems. We aspire to have a distinguished tradition of excellence in the theme areas ranging from thermal, mechanics, design and manufacturing to CAD/CAM/CAE. Department is committed to disseminate the advanced engineering education and pursues success in research as well. Department is dedicated to preparing students to face the emerging challenges facing by society. The department currently runs one undergraduate program B. Tech. (Mechanical Engineering) and one master'sprogram M. Tech. (CAD/CAM). Ph. D. program is also offered by the Department in all area of the Mechanical Engineering since Academic year 2016-2017. The Department is currently equipped with CAD Laboratory. Intake for M. Tech. CAD/CAM program is 34 seats + 2 seats (through DASA) including GATE scholarship, self-financed& sponsored seats. The program has been started from academic session 2016-17.

The Department's dream is to translate its research and to develop teaching methods so that the underprivileged minds can find technological solutions to future challenges. Students also have the opportunity to work with professionals from various fields in emerging areas such as Internet of Things (IoT), Machine Learning (ML), Smart Healthcare, and Artificial Intelligence (AI), Digital Manufacturing, Mechatronics etc. Currently, Department of Mechanical Engineering has four (04) regular faculties with few faculties expected to join this year. Faculty members of the department have excellent academic & research credentials and published numerous peer reviewed journal articles/ papers, Books, Book Chapters etc. in diversified field and having adequate experience in advanced research. The Department believes that by developing a culture of seeking for knowledge and dissemination of research findings, intellectually sound, self-motivated and reliant mechanical engineers and researchers, who will be the bedrock of our nation's match towards qualitative and massive technological development and dynamic industrialization, will be actualized. In other words, the department hopes to achieve the national goals and objectives of industrialization and self-reliance. As a result, it hopes to produce graduates with strong academic and practical background so that they can fit into the industry immediately upon graduation.

1.2 Vision

To be a global knowledge hub in mechanical engineering education, research, entrepreneurship and industry outreach services.

1.3 Mission

- Impart quality education and training to nurture globally competitive mechanical engineers.
- Provide vital state-of-the-art research facilities to create, interpret, apply and disseminate knowledge.
- Develop linkages with world class educational institutions and R&D organizations for excellence in teaching, research and consultancy services.

M. Tech. Mechanical Engineering (CAD/CAM)

2.1 Salient Features/ Philosophy of the M. Tech. Mechanical Engineering program

M. Tech. Mechanical Engineering (CAD/CAM) program offered at NIT Delhi is designed to equip the students with a unique blend of skill sets that include:

- Strong theoretical and experimental foundation
- Predominantly experiment oriented approach with access to well-equipped and specialized laboratories, and supervised internship/ Thesis work.
- Hands-on technical training
- Life skills orientation
- Hard and soft skills
- Business perspective, along with emphasis on innovation and entrepreneurship
- Specialized courses in advanced areas such as Robotics, Mechatronics, Biomechanics, etc.

Some of the salient features of the drafted curriculum of M. Tech are as follows:

- Minimum Credits requirements for completion of MTech program is 80.
- The Curriculum is based on the guidelines of National Education Policy (NEP) – 2020.
- The curriculum has embedded the Multi Exit/ Multi Entry in the M. Tech program.
- The curriculum is designed to meet the prevailing and ongoing industrial requirements.
- The curriculum includes Project based Education with adequate exposure for Thesis work.
- The curriculum is flexible and offers adequate Choice of Electives (Program Elective Courses/ Open Elective Courses).
- The curriculum inherits the Value based Education aims the Holistic Development of the students.
- The Curriculum offers Digital Pedagogy & Flipped Learning with adequate motivation for Entrepreneurship/ Startups.

Cardinal Mention:

a. Students exiting after completing 1st Year will be awarded Post Graduate Diploma in Mechanical Engineering (CAD/CAM) respectively. A minimum Credit requirement for Post Graduate Diploma is40 Credits.

2.2 Program Educational Objectives (PEOs)

The PEOs for the M. Tech. Mechanical Engineering (CAD/CAM) is to prepare engineers and technologist to participate and get placement in academic, research & development, consultancy in the leading organizations/Institutions of the country and abroad. This is well consistent with the institute's mission of preparing manpower with the technical skill, leadership, creativity and innovation for benefit of mankind and continuously striving for excellence.

PEO-1	To impart education in CAD/CAM & related fields to have all-round development of students in order to serve the global society.
PEO-2	To develop the critical thinking and problem solving ability amongst the students through application of various aspects/fundamentals of CAD/CAM to understand/ analyze/ solve the critical situations in the area amicably.
PEO-3	To develop independent research attitude through projects/dissertations and its administrative & financial management as well as its dissemination to the PG students.
PEO-4	To create awareness amongst the students for collaborative and multidisciplinary activities through usage of modern/emerging tools, technologies and research publications.
PEO-5	To encourage students to be ethically and socially responsible and articulate themselves to be a lifelong learner.

2.3 Program Outcomes (POs)

Program Outcomes (POs) are narrower statements that describe what the students are expected to know and be able to do upon the graduation. They relate the knowledge, skills and behaviour of the students acquire through the program. The POs are specific to the program and facilitate the attainment of PEOs.

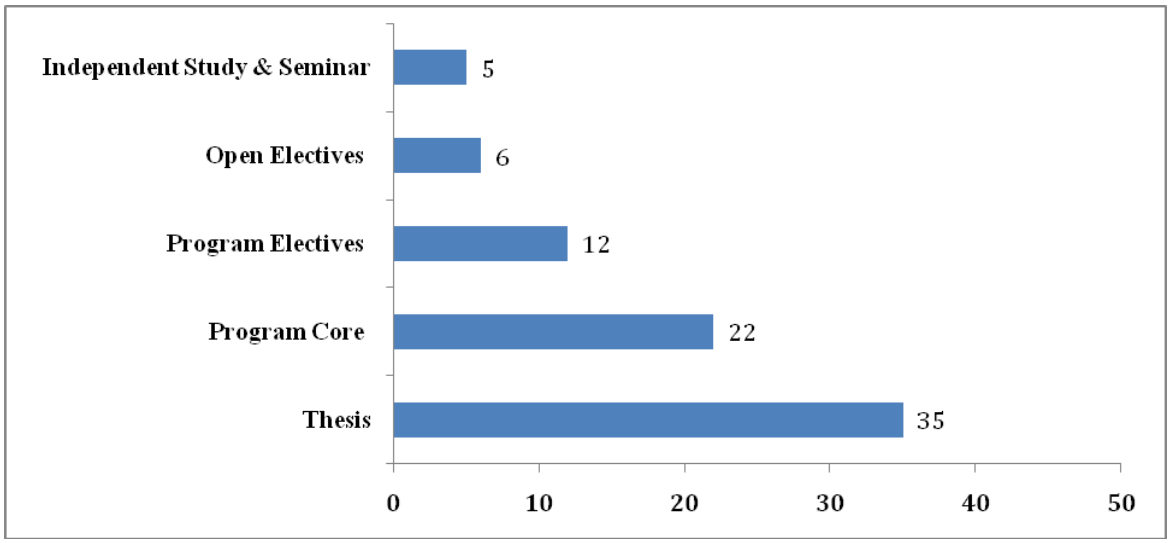
At the end of the program, the student shall be able to:

PO-1	An ability to independently carry out research /investigation and development work to solve practical problems.
PO-2	An ability to write and present a substantial technical report/document.
PO-3	Students should be able to demonstrate a degree of proficiency over the area of the CAD/CAM. The proficiency should be at a level higher than the requirements in the appropriate bachelor program.
PO-4	Develop and validate models to solve complex problems in design of manufacturing systems using modern engineering and computer assisted tools.
PO-5	Able to use state of art tools and techniques to model and analyze the problems pertaining to CAD/CAM.
PO-6	Engage in lifelong learning adhering to professional, ethical, legal, safety, environmental and societal aspects for career excellence.

2.4 Program Specific Objectives (PSOs)

PSO -1	Identify, formulate and evaluate multifaceted engineering problems to achieve optimized product design utilizing the advanced knowledge in manufacturing, production engineering, material science and thermal engineering domains.
PSO -2	Analyze, interpret and provide optimal solutions for realistic industrial, engineering related problems.
PSO -3	Attain excellence in using managerial tools and techniques for effective and efficient manufacturing and in developing leadership skills with ethical and environmental practices.

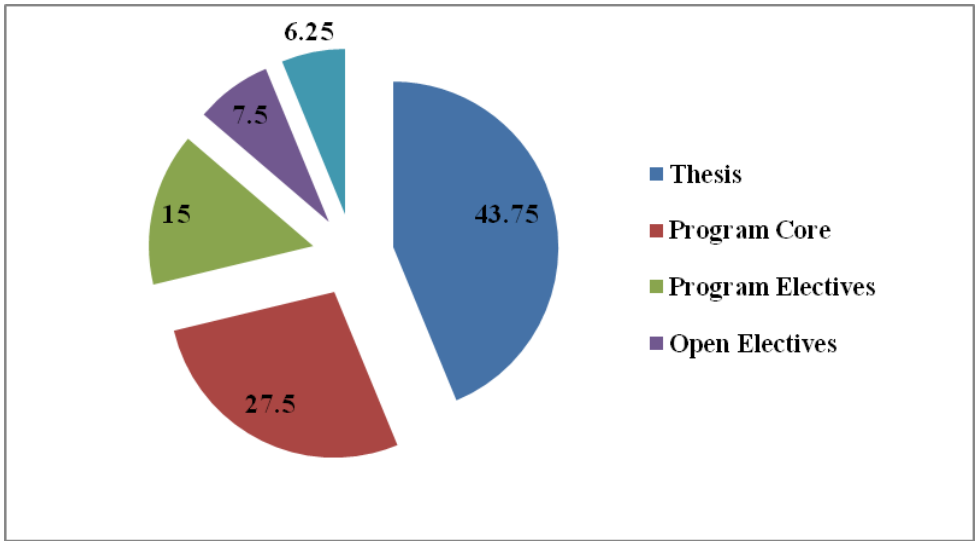
3.1 Credit Distribution



3.2 Semester wise Credit Structure

Credits						Total
Sl. No.	**Courses**	**1st Year**		**2nd Year**		
		1st Sem	**2nd Sem**	**3rd Sem**	**4th Sem**	
1	Program Core	11	11	-	-	22
2	Program Electives	6	6	-	-	12
3	Open Electives	3	3	-	-	6
4	Independent Study & Seminar	-	-	5	-	5
5	Thesis	-	-	15	20	35
Total		**20**	**20**	**20**	**20**	**80**

3.3 Credit Distribution (%)



4.1 Course Scheme

SEMESTER – I

Sl. No.	Course No.	Course Name	L	T	P	C
1	MELM 501	Program Core – 1	3	0	0	3
2	MELM 502	Program Core – 2	3	0	0	3
3	MELM 503	Program Core – 3	3	0	0	3
4	MELM 53X	Program Elective – 1	3	0	0	3
5	MELM 53X	Program Elective – 2	3	0	0	3
6	XXXX XXX	Open Elective –1	3	0	0	3
7	MEPM 521	Computer Aided Design and Manufacturing Laboratory (Program Core Lab-1)	0	0	4	2
Total			**18**	**0**	**4**	**20**

SEMESTER – II

Sl. No.	Course No.	Course Name	L	T	P	C
1	MELM 551	Program Core – 4	3	0	0	3
2	MELM 552	Program Core – 5	3	0	0	3
3	MELM 553	Program Core – 6	3	0	0	3
4	MELM 58X	Program Elective – 3	3	0	0	3
5	MELM 58X	Program Elective - 4	3	0	0	3
6	XXXX XXX	Open Elective – 2	3	0	0	3
7	MEPM 571	Computer Aided Engineering Laboratory (Program Core Lab-2)	0	0	4	2
Total			**18**	**0**	**4**	**20**

SEMESTER-III

Sl. No.	Course No.	Course Name	L	T	P	C
1	MEPM 621	Thesis	-	-	-	15
4	MEPM 622	Independent Study & Seminar	-	-	-	5
Total			**-**	**-**	**-**	**20**

SEMESTER-IV

Sl. No.	Course No.	Course Name	L	T	P	C
1	MEPM 671	Thesis	-	-	-	20
Total			**-**	**-**	**-**	**20**

4.2 Program Core and Elective Courses

Program Core- 1	**Program Elective- 1**
Computer Aided Design-MELM 501	Advanced Strength of Materials-MELM 531
	Advanced Materials Technology-MELM 532
	Advanced Mechanism Design-MELM 533
	Advanced Machining Processes-MELM 534
Program Core- 2	**Program Elective- 2**
Computer Integrated Manufacturing-MELM 502	Engineering Elasticity and Plasticity-MELM 536
	Advanced Optimization Techniques-MELM 537
	Computer Aided Product Design-MELM 538
Program Core- 3	**Program Elective- 3**
Computational Methods in Engineering- MELM 503	Advanced Mechanical Vibrations-MELM 580
	Robotics-MELM 581
	Production and Operations Management-MELM 582
	Computational Fluid Dynamics-MELM 583
	Advanced Finite Element Method- MELM 584
Program Core- 4	**Program Elective- 4**
Finite Element Method-MELM 551	Design for Manufacturing-MELM 586
	Product Design and Development- MELM 587
	Product Life Cycle Assessment-MELM 588
	Manufacturing of Plastic Products-MELM 589
Program Core- 5	**Open Elective- 1**
Modeling and Simulation-MELM 552	Digital Electronics
	Electrical Vehicles
	Control System

Program Core- 6	**Open Elective- 2**
Design of Experiments and Research Methodology- MELM 553	Soft Computing
	Machine Learning
	Power Electronics

*The List of program Electives offered by the Department is tentative and will be reviewed on yearly basis and depending upon the requirements of the Industry/ Availability of faculties.

**The Open Electives will be selected by the students from the Electives offered by Other Department for their MTech programs.

COURSE CONTENT PERFORMA

Course no: MELM 501	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Theory	Core Engineering course		
Course of title	Computer-Aided Design			
Course Coordinator				
Course objectives:	To acquire knowledge for generating high-quality images of massive geometric models quickly. To learn about surface modeling, physically based modeling, and surface visualization.			
Course Outcomes	CO1: Design various Curves, Surfaces and understand inherent mathematics. CO2: Perform various types of geometric transformations. CO3: Design various solid modeling; understand inherent mathematics and assembly design. CO4: Understanding of assembly design & analytical properties.			
POs				
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				
Text Books:					

	1. Computer-Aided Design: A Conceptual Approach, Jayanta Sarkar, CRC Press, 1st edition 2. Design Theory and Methods using CAD/CAE: The Computer-Aided Engineering Design Series, Kuang-Hua Chang, Academic Press, 1st Edition.
Reference Book:	
	1. Geometric Modeling: Michael E. Mortension, John Wiley, 1992. 2. Mathematical Elements of Computer Graphics: Roger and Adams, McGraw Hill, 1994. 3. CAD CAM Theory and Practice: I. Zeid, McGraw Hill, 1994. 4. Computer Aided Engineering Design, Saxena and Sahay, Anamaya N. Delhi, 2005.
Content	**Unit I:** **Introduction:** Historical Development, Geometric Modeling, Explicit and Implicit Equations, Intrinsic Equations, Parametric Equations, Coordinate Systems. **Unit II:** **Curve Design**: Fundamental of Curve Design, Parametric Space of a Curve, Blending Functions, Reparametrization, Space Curves, Straight lines, Spline Curves, Bezier Curves, B-Spline Curve, Rational Polynomials, NURBS. **Unit III:** **Surface Design**: Fundamental of Surface Design, Parametric Space of a Surface, Reparametrization of a Surface patch, Sixteen Point form, Four Curve Form, Plane surface, Cylindrical and Ruled Surfaces, Surface of Revolution, Bezier Surface, B-Spline Surface. **Unit IV:** **Solid Design:** Fundamental of Solid Design, Parametric Space of a Solids, Continuity and Composite Solids, Surfaces and Curves in a Solid. **Unit V:** **Solid Modeling:** Topology and Geometry, Set Theory, Boolean Operators, Set-membership Classification, Euler operators, Graph-Based Models, Boolean Models, Instances and Parameterized Shapes, Cell Decomposition, and Spatial Occupancy Enumeration, Sweep, Representation, Constructive Solid Geometry, Boundary Representation

	Unit VI: **Transformations**: Translation, Rotation, Scaling, Symmetry and Reflection, Homogeneous Transformations, Orthographic Projections, Axonometric Projections, Oblique Projections, Perspective Transformation. **Unit VII:** **Assembly Design**: Assembly-Modeling, Analytical Properties, Relational Properties and Intersections, Data Transfer Formats.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 502	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Theory	Core Engineering Course		
Course of title	Computer-Integrated Manufacturing			
Course Coordinator				
Course objectives:	To train on part programming and program generation from a CAD model. To train in machining in various CNC machines. To train on various modern measuring instruments.			
Course Outcomes	CO1: Understanding the fundamentals and Part Programming of Numeric Control Systems. CO2: Basic Understanding of the Feedback Devices and Actuation Systems. CO3: Programming and Applications of CMM & CIM CO4: Understanding of Advanced Manufacturing System & Material Handling.			
POs				

Semester	Autumn:		Spring:		
	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:	
	1. Computer-Aided Manufacturing, Tien-Chien Chang , Pearson, 3rd Edition 2. Computer-Aided Design and Manufacturing, Justin Riggs, Willford Press
Reference Book:	

1	1. Krajewski U and Ritzman LP, Operations Management: Strategy and Analysis, Pearson Education Pvt. Ltd., Singapore, 2002. 2. Chase RB, Aquilano NJ and Jacobs RF, Operations Management for Competitive Advantage, McGraw-Hill Book Company, NY, 2005. 3. Hopp WJ and Spearman ML, Factory Physics: Foundations of Manufacturing Management, McGraw-Hill, NY,Third Edition , 2008
Content	**Unit I:** **Functions and Components of CIM System**: Concept of CIMS, Group Technology and Cellular Manufacturing. Concurrent Engineering-Objectives, Tools and Applications Planning and Scheduling Functions in CIM System, **Computer Control and Adaptive Control System** CNC, DNC and AC. Flexible Manufacturing Systems-Concept and Classification, Types of Flexibility, pallets, fixtures, work handling systems, simulation and analysis in the design of FMS **Unit II:** **Fundamentals of Numerical Control:** Need and Future of NC Systems, Principles and Types of NC, Design Features of NC M/c Tools; Machining Centre, NC Part Programming: Manual, Computer Assisted-APT **Unit III:** **Feedback Devices-** Resolvers, Encoders, and Inductosyn. Point form, Four Curve Form, Plane surface, Cylindrical and Ruled Surfaces, Surface of Revolution, Bezier Surface, B-Spline Surface. **Actuation-** Systems Hydraulic, Pneumatic and Electromechanical.

	Unit IV: **Automated Quality Control Systems**-Working, Programming and Applications of CMM. Fundamentals of Automation in Manufacturing Systems: Manufacturing Systems, Concept Objectives, Types and Trends; Concepts of Mechanization, Automation and Integration. **Unit V:** **Automated Material Handling Systems:** Industrial Robots, Conveyors, AGVs, Automatic Storage and Retrieval Systems. **Advanced Manufacturing Systems**: Lean Manufacturing systems, Agile Manufacturing Systems, Reconfigurable Manufacturing Systems, Holonic Manufacturing Systems and Agent-Based Manufacturing Systems.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 503	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Theory	Core Engineering Course		
Course of title	Computational Methods in Engineering			
Course Coordinator				
Course objectives:	To familiarize students with computational methods in engineering problems. To expose the students to numerical solutions of partial. To apply finite element method for non-linear and structural dynamic problem.			
Course Outcomes	CO1: Solve systems of linear and non-linear equations using numerical techniques. CO2: Apply numerical techniques for integrating complicated functions. CO3: Understand and use of regression method for curve fitting. CO4: Analyze boundary value problems. CO5: Numerical solutions of partial differential equations Parabolic, elliptical method			
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36

Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				
Text Books:					
	1. Numerical Solution of Partial Differential Equations, K. W. Morton and D. F. Mayers, Cambridge University Press 2. The finite Difference Methods in Partial Differential Equations, A. R. Mitchell and D. F. Griffiths, John Wiley				
Reference Book:					
	1. Gupta S.K.(1995) Numerical Methods for Engineers, New Age International. 2. Chapra S.C. and Canale R.P.(2006) Numerical Methods for Engineers, 5th Ed; McGraw Hill. 3. A joint venture by IISc and IITs, funded by MHRD, Govt of India				
Content	**Unit I:** **Introduction:** Numerical methods, Systems of linear equations: Matrix notation, Determinants and inversion, Iterative methods, Relaxation methods. Solution of non-linear equations: Bisection method, Newton's method, computer programs. **Unit II:** **Numerical integration**: Newton-Cotes integration formulas, Trapezoidal Rules, Simpson's rules, Gaussian quadrature- One point, Two point, Three point, Adaptive integration. **Unit III:** **Curve fitting and approximation of functions**: Least square approximation, fitting of non-linear curves by least squares, regression analysis, multiple linear regression, nonlinear regression, computer programs.				

	Unit IV: **Boundary value problems:** Characteristic value problems: Shooting method, Derivative boundary conditions, Rayleigh–Ritz method, and Characteristic value problems. **Unit V:** **Numerical solutions of partial differential equations**: Parabolic, Explicit method, Implicit Method, Crank-Nicolson method, , Elliptic PDE , Laplace's equation, Iterative methods Poisson equation, Derivative boundary conditions, ADI method. Hyperbolic partial differential equations: Method of characteristics, Wave equation, finite difference method, stability, wave equation in two space dimensions, computer programs.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 551	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Theory	Core Engineering course		
Course of title	Finite Element Method			
Course objectives:	To study the fundamentals of finite element method. To apply finite element method for solving one dimensional and two dimensional structural and thermal problems. To apply finite element method for non-linear and structural dynamic problem.			
Course Outcomes	CO1: Understand basic concept of Finite Element Method. CO2: Finite Element Analysis of 1-D and 2-D problems. CO3: Solve the structural vibration and dynamics analysis. CO4: Solve engineering problems and thermal analysis in solid mechanics, fluid mechanics and heat transfer.			
POs				
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:	
	1. The Finite Element Method: Linear Static and Dynamic Finite Element Analysis, Thomas J. R. HughesDover Publications 2. Seshu P, Textbook of Finite Element Analysis, PHI. 2004
Reference Book:	

	1. A First Course in the Finite Element Method Daryl L. Logan Publisher CL Engineering Edition 2. Reddy, J.N., Finite Element Method in Engineering, Tata McGraw Hill, 2007. 3. Singiresu S.Rao, Finite element Method in Engineering, 5ed, Elsevier, 2012 4. Zeincowicz, The Finite Element Method 4 Vol set, 4th Edition, Elsevier 2007
Content	**Unit I:** **Introduction:** Basic Concept of Finite Element Method, Historical Background, FEM Applications, General Description of FEM, Commercial FEM Software Packages. Spring Element-Stiffness Matrix, Boundary Conditions, Solving Equations, Variational Formulation Annexure X 439 Approach, Rayleigh-Ritz Method, Principle of Minimum Potential Energy, Weighted Residual Method. Introduction of 0D, 3D and Rigid beam elements/mesh. Structural Vibration and Dynamic Analysis- a. Mode Shape b. Frequency Response analysis **Unit II:** **1-D Linear Static Analysis:** Bar and Beam Elements, Local and Global Coordinate System, Transformation of Coordinate Systems, Element Stress, Analysis of Truss, Natural Coordinate System, Interpolation Polynomial, Isoparametric Elements and Numerical Integration, Gaussian Quadrature Approach, Simple problems in 1-D. **Unit III:** **Finite Element Analysis of 2-D Problems:** Review of the Basic Theory in 2-D Elasticity, Plane Stress, 2-D Problems using Constant Strain Triangles (CST), Isoparametric Representation, Element Matrices, Stress Calculations. Finite Element Modeling and Simulation Techniques, Symmetry, Nature of FE Solutions, Error, Convergence, Adaptivity, Substructures (Super Elements) in FEA. **Unit IV:** Structural Vibration and Dynamic Analysis: Review of Basic Dynamic Equations, Hamilton's Principle, Element Mass Matrices, Free Vibration (Normal Mode) Analysis, Eigen Values and Eigen Vectors. Introduction to Transient Response Analysis.

	Unit V: Thermal Analysis: Review of Basic Equations of Heat Transfer, Steady State One Dimensional Heat Conduction, Governing Equations, Boundary Conditions, Element Characteristics, Simple Problems in 1-D
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 552	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Elective			
Course of title	Modeling and Simulation			
Course Coordinator				
Course objectives:	This subject will give an exposure to the students about plastics and the various manufacturing technologies available for their fabrication.			
Course outcomes	CO1: Understand basic probability and statistics. CO2: Understand the principle of modeling, basic simulation modeling and role & advantages of simulation. CO3: Understand different techniques of system simulation and dynamics. CO4: Understand the concept of simulation of Mechanical systems			

Semester	Autumn:		Spring:		
	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				
Text Books:					
	1. Simulation Modeling and Analysis,Averill Law,Elsevier 2. Principles Of Modeling And Simulation by John A Sokolowski and Catherine M Banks, John Wiley				
Reference Book:					
	1. Theory of Modeling and Simulation, Bernard P. Zeigler, Alexandre Muzy, Ernesto Kofman, Elsevier				

Content	**Unit I:** **Introduction**: A review of basic probability and statistics, random variables and their properties, Estimation of means variances and correlation. **Unit II:** **Physical Modeling:** Concept of System and environment, Continuous and discrete systems, Linear and non-linear systems, Stochastic activities, Static and Dynamic models, Principles of modelling, Basic Simulation modelling, Role of simulation in model evaluation and studies, advantages of simulation. **Unit III:** **System Simulation:** Techniques of simulation, Monte Carlo method, Experimental nature of simulation, Numerical computation techniques, Continuous system models, Analog and Hybrid simulation, Feedback systems, Computers in simulation studies, Simulation software packages. **Unit IV:** **System Dynamics:** Growth and Decay models, Logistic curves, System dynamics diagrams. Probability Concepts in Simulation: Stochastic variables, discrete and continuous probability functions, Random numbers, Generation of Random numbers, Variance reduction techniques, Determination of length of simulation runs. **Unit V:** Simulation of Mechanical Systems: Building of Simulation models, Simulation of translational and rotational mechanical systems, Simulation of hydraulic and pneumatic systems. Simulation of Manufacturing Systems: Simulation of waiting line systems, Job shop with material handling and Flexible manufacturing systems, Simulation software for manufacturing, Structure and development of expert systems.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 553	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Theory			
Course of title	Design of Experiments and Research Methodology			
Course Coordinator				
Course objectives:	To provide a perspective on research to the scholars so as to broaden their conceptions of what research involves. To impart knowledge on techniques related to research			
Course outcomes	CO1: Formulate research topics as per the literature and experimental data. CO2: Perform required statistical analyses for any univariate application in a business / industrial setting. CO3: Understand and review the underlying assumptions related to each statistical test and its interpretation. CO4: Apply the concept of factorial design of experiments.			
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:	
	1. A DOE Handbook:: A Simple Approach to Basic Statistical Design of Experiments, Bert Gunter and Daniel Coleman, CreateSpace Independent Publishing Platform 2. Design of Experiments: A Modern Approach, 1st Edition, Bradley Jones, Douglas C. Montgomery
Reference Book:	
	1. Design and Analysis of Experiments, Douglas C. Montgomery, Wiley

Content	**Unit I:** **Introduction:** Defining Research, Scientific Enquiry, Hypothesis, Scientific Method, Types of Research, Research Process and steps in it. Research Proposals – Types, contents, sponsoring agent's requirements, Ethical, Training, Cooperation and Legal aspects. **Unit II:** **Research Design:** Meaning, Need, Concepts related to it, categories; Literature Survey and Review, Dimensions and issues of Research Design, Research Design Process – Selection of type of research, Measurement and measurement techniques ,Selection of Sample, Selection of Data Collection Procedures, Selection of Methods of Analysis, Errors in Research. **Unit III:** Research Problem: Problem Solving – Types, Process and Approaches – Logical, Soft System and Creative; Creative problem solving process, Development of Creativity, Group Problem Solving Techniques for Idea Generation – Brain storming and Delphi Method **Unit IV:** **Research Modeling:** (a) Mathematical – Classification of Models, Development of Models, Stages in Model building, Principles of Modeling, Use of Analogy, Models as Approximations, Data consideration and Testing of Models (b) Heuristics and Simulation – Definition, Applications and reasons for using Heuristics, Heuristic Methods and approaches, Meta- Heuristics; Simulation – Meaning, Applications and Classification of Simulation Models, Process of Simulation, Steps and Features of Simulation Experiments and their Validation. **Unit V:** **Experimentation:** Objective, Strategies, Factorial Experimental Design, Applications of Experimental Design, Basic Principles – Replication, Randomization and Blocking, Guidelines for designing experiments; Laboratory Experiments, Methods of manipulating Variables, Errors in Experiments, Steps in Design of Experiments, Basis Process Optimization: Factorial Design principles, Two factor Factorial Design, General Factorial Design, Fitting response Curves and Surfaces, Blocking, Taguchi Approach to Parameter Design, Robust Design

	Unit VI: **Analysis and Report writing:** Analysis of Variance and Co-variance, Hypothesis Testing – Parametric and Non-Parametric Tests, Uni-variate and Bi-variate analysis.Pre-writing Considerations, Principles of Thesis Writing, Format of Report Writing, Format of Publication in Research Journals, Oral Presentations (Briefing).
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 534	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Theory			
Course of title	Advanced Machining Processes			
Course Coordinator				
Course objectives:	This course of advanced machining processes has been designed with the objective of providing opportunity to students to understand the various advanced machining processes with their basic sciences. Students would be able to apply the processes for most relevant industrial problems. The relevance of imposed tolerances on costs and production time and the modeling of advanced machining processes are also taken into consideration keeping in mind sustainability issues.			
Course outcomes	CO1: Understand the various advanced machining processes. CO2: Identify advanced machining Processes for machining of different advanced engineering materials. CO3: Analyse the process capabilities for creating desired features along with machining quality as well as productivity. CO4: Illustrate the machining performance characteristics and analysis for optimization of process performance. CO5: Analyse the sustainability issues during the selection of machining processes.			
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				
Text Books:					

	1. Pandey P. C.&Shan H.S., Modern Machining Process, Tata McGraw Hill 2. Dr. Bhattacharya Amitabh, New Technology, The Institution of Engineers Publication.
Reference Book:	
	1. V.K. Jain, Advanced Machining Processes, Allied Publishers, India 2. Hassan Abdel –Gawad EI-Hofy, Advanced Machining Processes, McGraw Hill, Mechanical Engineering Series
Content	**Unit I:** **Introduction:** Mechanical Advanced Machining Processes: An Introduction of advanced machining processes, Importance and their classification, Working principles, mechanism, input process parameters, machining responses, effects of input parameters on machining responses, consumables, applications, limitations and advantages for Water Jet Cutting (WJC), Abrasive Jet Machining (AJM), Abrasive Water Jet Machining (AWJM), Ultrasonic Machining (USM), Water Jet Machining (WJM). **Unit II:** **Thermoelectric Advanced Machining Processes**: Electrical discharge machining (EDM) & CNC Wire-EDM: Mechanisms of material removal, basic circuitry, evaluation of *MRR*, machining accuracy, surface finish, tool material, dielectric fluid, applications and limitations. Laser beam machining (LBM): Production of Lasers, Types of Lasers**,** Basic principle of material removal, thermal analysis, cutting speed, accuracy, applications and limitations. Electron beam machining (EBM): Working principle, Electron beam machining system, Process parameters, Characteristics of the process and Applications, Plasma arc machining (PAM): Working Principle, Plasma arc cutting system, elements of plasma arc cutting system, Process performance and applications, Ion beam machining (IBM): Introduction, MRR, Accuracy and surface effects, Applications, Numerical Problems. **Unit III:** **Electrochemical and Chemical Advanced Machining Processes:** Electro-chemical Machining (ECM):Introduction, ECM Machine Tool, Advantages, Limitations and Applications, Theory of ECM, Maximum permissible feed rate in ECM, Electrolyte Conductivity (K), Process control and characteristics, Electrochemical drilling (ECD), Shaped Tube Electrolytic

	Machining (STEM), Electrostream Drilling (ESD), Electro-chemical Jet Drilling, Electrochemical Deburring, Types of Chemical machining processes, basic principles, applications and limitations. Chemical milling, Photo chemical milling, Electro polishing and their process parameters, Numerical Problems. **Unit IV:** **Hybrid Machining Processes, Evaluation And Development:** Introduction and classification of Hybrid machining processes. Hybrid Electrochemical Processes: Electrochemical grinding (ECG), Electrochemical honing (ECH), Electrochemical super finishing, Electrochemical buffing, Ultrasonic assisted ECM, Laser assisted ECM, Hybrid Thermal Processes: Electrical discharge grinding (EDG). Electrical discharge diamond grinding (EDDG), Abrasive electro discharge machining, EDM with Ultrasonic assisted, Electrochemical discharge grinding (ECDG). **Unit V:** **Sustainability Issues in Advanced Machining and Finishing Processes:** Advanced Finishing Processes (AMPs): Classification, Advanced abrasive based finishing processes, Magnetic field assisted advanced finishing processes (AFPs), Magneto-rheological fluids based finishing processes, Need for sustainability, Major sustainability issues and possible solution strategies.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 537	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	No	No
Type of course	Elective			
Course of title	Advanced Optimization Techniques			
Course Coordinator				
Course objectives:	To introduce the various optimization techniques with applications and their advancements in design engineering.			
Course Outcomes	CO1: Explain the fundamental knowledge of linear programming and dynamic programming problems. CO2: Apply classical optimization techniques for optimize the real problems. CO3: Analyze the basics of constrain and unconstrained optimization problems. CO4: Apply traditional optimization techniques to achieve the optimize design the machine element			
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Ni l				
Text Books:					
	1. Optimization Techniques, C. Mohan, Kusum Deep, New Age Science 2. Classical and Modern Optimization, Guillaume Carlier, world scientific.				
Reference Book:					

1	1. Optimization Techniques: An Introduction, L. R. Foulds, Springer 2. Applications of Advanced Optimization Techniques in Industrial Engineering, Abhinav Goel, Anand Chauhan, A. K. Malik, Taylor & Francis group
Content	**Unit I:** **Introduction:** Introduction to Optimization, Adequate and Optimum Design, Principles of Optimization, Statement of an Optimization Problem, Classification, Formulation of Objective Function, Design Constraints. **Unit II:** **Classical Optimization Techniques:** Single Variable Optimization, Multivariable Optimization with no Constraints, Exhaustive Search, Fibonacci Method, Golden Selection, Random, Pattern and Gradient Search Methods, Interpolation Methods, Quadratic and Cubic, Direct root Method. **Unit III:** **Multi Variable Unconstrained and Constrained Optimization**: Direct Search Methods, Descent Methods, Conjugate Gradient Method, Indirect Methods, Transformation Techniques, Penalty Function Method. **Unit IV:** **Traditional Optimization Techniques**: Genetic Algorithms, Simulated Annealing, Tabu Search Methods. Optimization techniques used by commercial FEA software. For example – Nastran and Hypermesh optistruct. **Unit V:** **Optimum Design of Machine Elements**: Desirable and Undesirable Effects, Functional Requirements, Material and Geometrical Parameters, Design of Simple Axial, Transverse Loaded Members for Minimum Cost and Minimum Weight, Design of Shafts, Springs, Vibration Absorbers.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 538	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Elective			
Course of title	Computer Aided Product Design			
Course Coordinator				
Course objectives:	To impart the knowledge of computer aided product design and various approach of process planning and manufacturing			
Course outcomes	CO1: Understand about basic of product design, concept generation & concept testing. CO2: Understand and use Rapid Prototyping processes in various applications. C03: Apply rapid prototype in manufacturing.			
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:	
	1. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson and David Rosen, Elsevier 2. Computer Aided Analysis and Design, Srinivasa Prakash Regalla, Willey
Reference Book:	
	1. CAD and Rapid Prototyping for Product Design, Douglas Bryden, Elsevier

Content	**Unit I:** **Introduction:** Significance of product design, product design and development process, sequential engineering design method, the challenges of product development, World Class manufacturing, Product definition, Engineering Design Process, Prototype Design and Innovation, Impact of Cost, Quality and time, Key Process Requirements for Rapid Prototyping. **Unit II:** Prototyping: Product Prototyping, Prototype planning and management, Prototype cost estimation, Prototype Design Methods and tools. Materials Selection and Product Prototyping. **Unit III:** Phases of Prototyping. Fundamentals of R.P. Classification of R.P. Processes. Concept Generation: Activities of concept generation, clarifying problem, search both internally and externally, explore the output, Concept Testing: Elements of testing: qualitative and quantitative methods including survey, measurement of customers' response **Unit IV:** Rapid Prototyping Process: - Automated Processes, Difference between Additive and Subtractive Processes, Process Chain, steps in involved in R.P. **Unit V:** Types of R.P. systems: - Liquid Based, Solid Based, & Powder Based. **Unit VI:** Application of R.P. in Manufacturing and Rapid Tooling: Rapid Prototyping and Manufacturing Benchmarking, Modeling practice on softwares such as IDEAS, UNIGRAPHICS, ProE, etc.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 582	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	No	No
Type of course	Elective			
Course of titles	Production and Operations Management			
Course Coordinator				
Course objectives:	To introduce the various production and operations management methods to be followed in the industry			
Course outcomes	CO1:Understand the importance of core features of the operations and production management CO2: understanding of Supply chain Management. CO3: Students will develop an integrated framework for strategic thinking and decision making to analyze the enterprise CO4 : Understand the environment's impact while dealing with production, use of technology and waste management.			
Semester	Autumn		Spring	
	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				
Text Books:				
	1. Production and Operations Management Systems,Sushil Gupta and Martin Starr, CRC Press			
Reference Book:				
	1. Production and Operations Management: Manufacturing and Services, Richard B. Chase and Nicholas J. Aquilano, Richard D Irwin			

Content	**Unit I:** **Introduction:** Operations strategy, Framework for operations strategy in manufacturing, Operations strategy services, Meeting the competitive challenges. **Unit II:** **Managing the Supply Chain:** Supply chain management, Purchasing, JIT purchasing, Global sourcing, Electronic information flow, Forecasting, Qualitative techniques, Focus forecasting, Aggregate planning techniques, Inventory systems for independent demand, Inventory systems for independent time period models, Inventory systems for dependent demand, MRP type systems, Embedding JIT into MRP, Lot sizing in MRP, Advanced MRP Systems. **Unit III:** **Operations Scheduling:** Scheduling & control functions, Priority rules and techniques, Single machine scheduling problems, Scheduling in jobs on 'm' machines, Personal scheduling, Simulation methodology, Two assembly simulation. **Unit IV:** Design of Facilities & Jobs: Strategic capacity planning concepts, determining capacity requirements, Planning service capacity, JIT production systems, Process and Product layout, GT layout, Retail service layout, Computer aided layout techniques. Job design and work measurement, Considerations in job design, Work measurements and standards, Financial incentive plans, Learning curves and its applications. **Unit V:** **Product Design & Process Selection:** Product design process, Designing for the customer QFD, Value analysis, designing products for manufacturer & assembly. Process selection, Waiting line management & models, **Unit VI:** **Quality management:** Quality specifications & costs, Tolls and procedures for continuous improvement, Shingo system of fail-safe design, Review of SQC models.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 583	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Elective			
	Computational Fluid Dynamics			
Course Coordinator				
Course objectives:	To provide an overview of the theory and numeric's of CFD and an introduction to the use of commercial CFD codes to analyze flow and heat transfer in problems of practical engineering interest			
Course Outcomes	CO1: Understand basic knowledge of discretizing techniques in engineering applications. CO2: Analyze the wave equation for real world problems CO3: Apply the basics concept of incompressible flow for a given fluid -flow case. CO4: Select and formulate various CFD problems in case of compressible flow domain.			
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:	
	1. Computational Fluid Dynamics, John Anderson, McGraw-Hill Education. 2. Computational Fluid Mechanics and Heat Transfer, Richard H. Pletcher and John C. Tannehill, CRC Press
Reference Book:	

	1. Computational Fluid Dynamics and Heat Transfer, Pradip Majumdar, Taylor & Francis
Content	**Unit 1:** **Introduction:** Finite Difference Method, Finite Volume Method, Finite Element Method, Governing Equations and Boundary Conditions. **Unit II:** Hyperbolic equations: Explicit Schemes and Von Neumann Stability Analysis, Implicit Schemes, Multi Step Methods, Nonlinear Problems, Second Order One-Dimensional Wave Equations, Burgers Equations, Explicit and Implicit Schemes, Runge-Kutta Method. **Unit III:** Formulations of Incompressible Viscous Flows: Formulations of Incompressible Viscous Flows by Finite Difference Methods, Pressure Correction Methods, Vortex Methods. manufacturer& assembly. Process selection, Waiting line management & models, **Unit IV:** Treatment of Compressible Flows: Potential Equation, Euler Equations, Navier-Stokes System of Equations, Flow Field-Dependent Variation Methods, Boundary Conditions, Example Problems. **Unit V:** Finite Volume Method:Finite Volume Method via Finite Difference Method, Formulations for Two and Three-Dimensional Problems. Unit6: 6 Standard Variational Methods: Linear Fluid Flow Problems, Steady State Problems, Transient Problems.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 589	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Elective			
Course of title	Manufacturing of Plastic Products			
Course Coordinator				
Course objectives:	This subject will give an exposure to the students about plastics and the various manufacturing technologies available for their fabrication.			
Course Outcomes	CO1: Understand the polymer processing technologies. CO2: Evaluate mechanical & thermal properties of plastics material. CO3: Determine the mechanical properties of material. CO4: Apply the material characterization techniques for characterization of materials.			

Semester	Autumn:		Spring:		
	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:	
	1. Polymer Processing: Principles and Design, Donald G. Baird and Dimitris I. Collias,McGrElsevier
Reference Book:	
	1. Polymer Processing, D. H. Morton-Jones, Elsevier

Content	**Unit I:** **Introduction to Polymers & Plastics** –Types of polymers, Commodity plastics and special purpose plastics, Environment friendly plastics, Plastic recycling & plastic identification codes, Additives and fillers **Unit II:** **Polymer processing technologies** - Melt flow, Extrusion, Injection molding, Rotational molding, Compression molding, Polymer foaming, Vacuum forming, Filament winding, Thermoforming, Calendaring, Resin transfer molding, foaming of polymers and its application in industries. **Unit III:** Fiber Reinforced Polymeric Composites - Introduction, Types of fibers, Manufacturing techniques, Micro & Macro mechanical analysis of Lamina, Testing of composites, fiber volume fraction, tensile, shear, compressive, flexural and thermoelastic responses of lamina and laminates, shear test, notched strength, essential work of fracture, fracture toughness, non destructive testing. **Unit IV:** Testing of polymer products - Testing of plastics and dry rubber products – mechanical properties – tensile, Flexural, compressive, impact, hardness, abrasion and fatigue resistance tests, Thermal properties – thermal conductivity, thermal expansion and brittleness temperature, heat deflection temperature **Unit V:** Types of material characterization techniques: Scanning electron microscope, MFI, capillary rheometer test, viscosity, gel time and peak exothermic temperature. Manufacturing of test specimens **Unit VI:** Selecting plastics for end-applications Automotive applications, Aerospace applications, House-hold applications, Textile applications, Food & packaging applications
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 586	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Elective			
Course of title	Design for Manufacturing			
Course Coordinator				
Course objectives:	To acquire knowledge for need and manufacturing based design and assembly.			
Course Outcomes	CO1: Understand to relate design rules for manufacturability, the basic principles of designing for economical production-creativity in design. CO2: Understand the principles of selection of materials for product development. CO3: Analyze the effects of thermal stresses in welded joints. Understand the various advantages and limitations of joining techniques. CO4: Apply the Design guide lines for extruded sections. Remember Keeler -Goodman formability diagram and its concept.			

Semester	Autumn:		Spring:		
	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				
Text Books:					
	1. Design for Manufacturability Handbook, James Bralla, McGraw-Hill Education				
Reference Book:					

	1. Design for Manufacturability: How to Use Concurrent Engineering to Rapidly Develop Low-Cost, High-Quality Products, David M. Anderson, McGraw-Hill Education
Content	**Unit I:** **Introduction:** Design philosophy steps in Design process - General Design rules for manufacturability - basic principles of design Ling for economical production - creativity in design. Materials: Selection of Materials for design Developments in Material technology - criteria for material selection - Material selection interrelationship with process selection process selection charts. **Unit II:** **Machining Process:** Overview of various machining processes - general design rules for machining - Dimensional tolerance and surface roughness - Design for machining - Ease - Redesigning of components for machining ease with suitable examples. General design recommendations for machined parts. **Unit III:** **Metal Casting:** Appraisal of various casting processes, selection of casting process, - general design considerations for casting - casting tolerances - use of solidification simulation in casting design - product design rules for sand casting. **Unit IV:** **Metal Joining:** Appraisal of various welding processes, Factors in design of weldments - general design guidelines - pre and post treatment of welds - effects of thermal stresses in weld joints - design of brazed joints. Forging - Design factors for Forging - Closed dies forging design - parting lines of die5 drop forging die design - general design recommendations. Extrusion & Sheet Metal Work: Design guidelines for extruded sections - design principles for Punching, Blanking, Bending, Deep Drawing - Keeler Goodman Forming Line Diagram - Component Design for Blanking. **Unit V:** **Assemble Advantages**: Development of the assemble process, choice of assemble method assemble advantages social effects of automation. Automatic assembly transfer systems, Continuous transfer, intermittent transfer, indexing mechanisms, and operator - paced free – transfer machine.

	Unit VI: **Design Of Manual Assembly:** Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MEPM 521	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Practical			
Course of title	Computer Aided Design and Manufacturing Laboratory			
Course outcomes	CO1: Develop solutions in the areas of design and simulation in various research fields. CO2: Design and validate technological solutions to defined problems and communicate clearly and effectively for the practical application of their work.			
Course objectives:	To review and train in CAD/CAM modeling			
POs				
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	0	0	6	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Book:	Computer aided design Thomas J. R. Hughes, Publisher, Dover Publications
Reference Book:	
	A First Course in the Finite Element Method, Daryl L. Logan, Publisher, CL Engineering

Content	**CAD Lab:** CAD Introduction. Sketcher, Solid modeling – Extrude, Revolve, Sweep, etc and Variational sweep, Loft, etc, Surface modeling –Extrude, Sweep, Trim etc and Mesh of curves, Free form etc, Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc, Assembly-Constraints, Exploded Views, Interference check, Drafting-Layouts, Standard & Sectional Views, Detailing & Plotting. Exercises in Modeling and drafting of Mechanical Components -Assembly using Parametric and feature based Packages like PRO-E / SOLID WORKS /CATIA / NX etc. (36 hours) **CAM Lab:** Simulation and Machining using CNC / DNC Machine Tools – Use of FEM Packages - Relational Data Base – Networking – Practice on Computer Aided Measuring Instruments - Image Processing – Software Development for Manufacturing – CNC Controllers – Use of advanced CNC Machining Packages – Business Data Processing. (36 hours)
Course Assessment	Continuous Evaluation 50% End Semester 50%

Course no: MEPM 571	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	No	No
Type of course	Practical			
Course of title	Computer Aided Engineering Laboratory			
Course outcomes	CO1: Apply the fundamental knowledge of discretizing methods in solving problems in the domain of mechanical engineering. CO2: Apply analytical, practical and soft skills in solving problems in the domain of structural and fluid flow problems.			
Course objectives:	● To train on various areas of finite element analysis of mechanical components.			
POs				

Semester	Autumn:		Spring:		
	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	0	0	6	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Book:	
	1. Fundamentals of Computer-Aided Engineering By Benny Raphael, Ian F. C. Smith
Reference Book:	
	1. A First Course in the Finite Element Method, Daryl L. Logan, CL Engineering

Content	**CAE Lab:** Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ NASTRAN etc., Exercises shall include analysis o 1. FEA introduction 2. CAD Import 3. Types of elements 0D-1D-2D-3D-Rigid Beam Elements 4. Meshing – 2D 3D Meshing 5. Convergence of mesh size 6. Defining mesh Joints 7. Application of Loads and boundary conditions 8. Solver – Types of analysis a. Machine elements under Static loads b. Thermal Analysis of mechanical systems c. Modal Analysis d. Machine elements under Dynamic loads e. Non-linear systems 9. Post processing – a. Viewing FEA results – Stress, deflection, Mode shapes etc. b. Interpretation of FEA Results for design validation.10) Machine elements under Static loads 11) Thermal Analysis of mechanical systems 12) Modal Analysis 13) Machine elements under Dynamic loads Non-linear systems
Course Assessment	Continuous Evaluation 50% End Semester 50%

Course no: MELM 531	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Elective			
Course of title	Advanced Strength of Materials			
Course Coordinator				
Course objectives:	To provide knowledge in the design of 2D and 3D members by understanding their state of stresses and the design of curved members and non circular sections.			
Course Outcomes	CO1: Apply the stress-strain relationships for homogenous, isotropic materials. CO2: Calculate the stresses and strains in axially-loaded members, circular torsion members, and members subject to flexural loadings. CO3: Calculate the stresses and strains associated with thin-wall spherical and cylindrical pressure vessels. CO4: Understand the Methods of computing contact stresses & deflection of bodies in point contact.			
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36

Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				
Text Books:					
	2. Advanced Strength of Materials, J. P. Den Hartog, Dover Publications 3. Advanced Mechanics of Materials and Applied Elasticity, Ansel C. Ugural, Saul K. Fenster, Prentice Hall				
Reference Book:					
	1. Introduction to Mechanics of Solids by Crandell, Dahl and Lardner, McGraw Hill 2. Strength of Materials DS Bedi. 3. Mechanics of Materials by Dr.Kirpal Singh, Standard Publishers & Distributors. 4. Strength of Materials by R.S. Lehri, S.K Kataria and Sons				

Content	**Unit I:** **Shear Centre:** Bending axis and shear center-shear center for axi-symmetric and unsymmetrical sections. Unsymmetrical bending: Bending stresses in Beams subjected to Nonsymmetrical bending; Deflection of straight beams due to nonsymmetrical bending. **Unit II:** **Curved Beam Theory:** Winkler Bach formula for circumferential stress – Limitations – Correction factors – Radial stress in curved beams – closed ring subjected to concentrated and uniform lads- stresses in chain links. **Unit III:** **Torsion:** Torsion of a cylindrical bar of Circular cross Section; Saint-Venant's semi-inverse methods; Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section; Hallow thin wall torsion members, Multiply connected Cross section, Thin wall torsion members with restrained ends. Axi-Symmetric Problems: Rotating Discs – Flat discs, Discs of uniform thickness, Discs of Uniform Strength, Rotating Cylinders. **Unit IV:** **Theory of Plates:** Introduction; Stress resultants in a flat plate; Kinematics: Strain- Displacement relations for plates; Equilibrium equations for small displacement theory of flat plates; Stress – Strain – Temperature relation for Isotropic plates: Strain energy of a plate; Boundary conditions for plate; Solution of rectangular plate problem; Solution of circular plate problem. **Unit V:** Beams on Elastic Foundation:General theory; Infinite Beam subjected to Concentrated load; boundary conditions; Infinite beam subjected to a distributed lad segment; Semi-infinite beam with concentrated load near its end; Short Beams. **Unit VI:** **Contact Stresses:** Introduction, problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Methods of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact. Normal and Tangent to contact area.

Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 532	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Elective			
Course of title	Advanced Materials Technology			
Course Coordinator				
Course objectives:	• To study the behavior of engineering materials. • To study the various modern materials, properties and their applications. • To understand the selection of metallic and non-metallic materials for various engineering applications.			
Course outcomes	CO1: Select suitable welding processes for joining different materials. CO2: Analyze metal removal mechanism in subtractive processes. CO3: Analyze and select appropriate transformation process to develop composites. CO4: Select a hybrid processor coating technology to improve the quality of products.			
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				
Text Books:					
1	1. Mechanics Of Composite Materials, Robert M. Jones, CRC Press 2. Mechanics of Composite Materials, Autar K. Kaw, CRC Press				

Reference Book:	
	1. Carter, C.B., and Grant, N. M., "Ceramic Materials: Science and Engineering", Springer, 2007. 2. Bralla, J. C., "Design for Manufacturability Handbook", McGraw-Hill Professional; 2/e, 1998
Content	**Unit I:** **Introduction to Composite Materials:** Definition, Classification, Types of matrices & reinforcements, characteristics &selection, Fiber composites, laminated composites, particulate composites, prepregs, sandwich construction. **Unit II:** **Micro Mechanical Analysis of a Lamina**: Introduction, Evaluation of the four elastic moduli – Rule of mixture, ultimate strengths of unidirectional lamina. **Unit III:** Macro Mechanics of a Lamina: Hooke's law for different types of materials, number of elastic constants, Two – dimensional relationship of compliance & stiffness matrix. Hooke's law for two dimensional angle lamina, engineering constants – angle lamina, Invariants, Theories of failure. **Unit IV:** Macro Mechanical Analysis of Laminate: Introduction, code, Kirchoff hypothesis – CLT, A, B, & D matrices, Engineering constants, Special cases of laminates, Failure criterion. **Unit V:** Manufacturing: Layup and curing – open and closed mould processing – Hand lay –up techniques – Bag moulding and filament winding. Pultrusion, pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance – Introduction, material qualification, types of defects, NDT methods. **Unit VI:** Application Developments: Aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment-future potential of composites.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 536	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Elective			
Course of title	Engineering Elasticity and Plasticity			
Course Coordinator				
Course objectives:	• To study the elastic and plastic behavior of engineering materials.			
Course outcomes	CO1: Determine the stress and strain relations and in Cartesian coordinate systems. CO2: Solve 2D Cartesian coordinate system using generalized Hooks law and Airy's stress functions. CO3: Determine the stress and strain relations and in polar coordinate systems. Solve elementary problems of axi-symetry and 3D Coordinate systems. CO4: Understand and relate simple plasticity theory concepts. Correlate and apply the theory of elasticity to solve civil engineering solutions.			
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:	
	1. Elasticity and Plasticity: The Mathematical Theory of Elasticity and The Mathematical Theory of Plasticity, J. N. Goodier (Author), Jr., P. G. Hodge (Author), Dover Publications 2. Continuum Mechanics: Elasticity, Plasticity, Viscoelasticity, Ellis H. Dill, Dover Publications

Reference Book:	
	1. E.P. Popov, Engineering Mechanics of Solids, 2nd Ed., Prentice Hall India, 1998. 2. 3 W.F.Chen and D.J.Han., Plasticity for structural Engineers., Springer-Verlag., NY., 1988. 3. Hoffman and Sachs, Theory of Plasticity - McGraw Hill., 2nd ed. 1985 4. 5. Johnson and Mellor, Engineering Plasticity- Van-Nostrand., 1st edition, 1983
Content	**Unit I:** **Elasticity:** Analysis of stress and strain, Definition of stress and strain at a point, Equilibrium and compatibility equations, Transformation of stress and strain at a point Principal stresses and strains: Stress and strain invariants, hydrostatic and deviator stress strains. **Unit II:** **Plane stress and plane strain:** - Simple two-dimensional problems in Cartesian and polar co-ordinates, Airy's stress function in rectangular and polar coordinates. **Unit III:** **Stress-strain relations for linearly elastic solids:** Generalized Hooke's law. Solution of axi-symmetric problems, stress concentration due to presence of a circular hole, Elementary problems of elasticity in three dimensions. **Unit IV:** **Torsion:**St.Venant's approach-Prandtl's approach – Membrane analogy - Torsion of thin walled open and closed sections. **Unit V:** **Plasticity:** Physical Assumptions – Yield criteria - Tresca and VonMises criterion of yielding, plastic stress strain relationship, Elastic plastic problems in bending. Some engineering applications of elasticity and plasticity
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 539	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	No	No
Type of course	Elective			
Course of title	Advanced Mechanical Vibrations			
Course Coordinator				
Course objectives:	• To understand the fundamentals of vibration phenomenon and its measurement. • To know the various constraints of vibration system and its analysis. • To study the vibrations of various generic components, its effect on balancing and the devices for its measurements.			
Course Outcomes	CO1: Determine the natural frequency of transverse vibrations of the shaft and torsional vibrations of rotor systems. CO2: Analyze the mathematical modeling of the two degrees of freedom systems and explain about the working principle of vibration absorber. CO3: Compute the natural frequencies and mode shapes of a Multi-degree of freedom system and explain the modal analysis of vibrating system. CO5: Apply classical mechanical approach to construct equations of motion for dynamical systems,			
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				
Text Books:					

	1. Advanced Vibration Analysis, S. Graham Kelly, CRC Press
Reference Book:	
	1. Advanced Engineering Dynamics, Jerry H. Ginsberg, CRC press
Content	
	Unit I: **Introduction:** Characterization of engineering vibration problems, Review of single degree freedom systems with free, damped and forced vibrations. **Unit II:** Two-degree of Freedom Systems: Principal modes of vibration, Spring coupled and mass coupled systems, Forced vibration of an undamped close coupled and far coupled systems, Undamped vibration absorbers, Forced damped vibrations, Vibration isolation. **Unit III:** **Multi-degree Freedom systems:** Eigen-value problem, Close coupled and far coupled systems, Orthogonality of mode shapes, Modal analysis for free, damped and forced vibration systems, Approximate methods for fundamental frequency- Rayleigh's, Dunkerely, Stodola and Holzer method, Method of matrix iteration, Finite element method for close coupled and far coupled systems. **Unit IV** Continuous systems: Forced vibration of systems governed by wave equation, Free and forced vibrations of beams/ bars. **Unit V:** Transient Vibrations: Response to an impulsive, step and pulse input, Shock spectrum. **Unit VI:** Non-linear Vibrations: Non-linear systems, Undamped and forced vibration with non-linear spring forces, Self-excited vibrations.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 587	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	No	No
Type of course	Elective			
Course of title	Product Design and Development			
Course Coordinator				
Course objectives:	To gain knowledge on multiple functional areas like marketing, finance, industrial design, engineering and production in creating a new product.			
Course outcomes	CO1: Describe the characteristics used for product design and development. CO2: Apply structural approach to concept generation, selection and testing. CO3: Identify various aspects of design such as industrial design, design for manufacture and product architecture. CO4: Explain various principles and technologies used for the preparation of prototype.			
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:	
	1. Product Design and Development, Karl T. Ulrich and Steven D. Eppinger, McGraw-Hill Education
Reference Book:	

	1. Making It: Manufacturing Techniques for Product Design, Chris Lefteri, McGraw-Hill Education
Content	**Unit I:** Introduction: Significance of product design, product design and development process, sequential engineering design method, the challenges of product development. **Unit II:** Product Planning and Project Selection: Identifying opportunities, evaluate and prioritize projects, allocation of resources **Unit III:** Identifying Customer Needs: Interpret raw data in terms of customers need, organize needs in hierarchy and establish the relative importance ofneeds. **Unit IV:** Product Specifications: Establish target specifications, setting final specifications Concept Generation: Activities of concept generation, clarifying problem, search both internally and externally, explore the output, Industrial Design: Assessing need for industrial design, industrial design process, management, assessing quality of industrial design **Unit V:** Concept Selection: Overview, concept screening and concept scoring, methods of selection. Theory of inventive problem solving (TRIZ): Fundamentals, methods and techniques, General Theory of Innovation and TRIZ, Value engineering Applications in Product development and design, Model-based technology for generating innovative ideas. Concept Testing: Elements of testing: qualitative and quantitative methods including survey, measurement of customers' response. **Unit VI:** Intellectual Property: Elements and outline, patenting procedures, claim procedure, Design for Environment: Impact, regulations from government, ISO system.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 588	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Elective			
Course of title	Product Life Cycle Assessment			
Course Coordinator				
Course objectives:	To know about the various aspects of Product life cycle assessment and management.			
Course Outcomes	CO1: Student will understand the concept of Product Life Cycle Management & its strategy identification and selection. CO2: Students will understand the cost management in design changes, concurrent engineering, assembly, robust design, failure mode and effect-analysis. CO3: Students will understand about applicability of FEM, Static analysis, thermal analysis, dynamic analysis.			
Pos				
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:	
	Product Lifecycle Management: Driving the Next Generation of, Lean Thinking, Michael Grieves, Elsevier
Reference Book:	Product Lifecycle Management: Driving the Next Generation of, Lean Thinking, Michael Grieves, Elsevier

Content	**Unit I:** Product Life Cycle Management – Need for PLM, Components of PLM, Product Data and Product workflow, Drivers for Change, The PLM Strategy, Developing a PLM Strategy, A Five-step Process. **Unit II:** Strategy Identification and Selection: Strategy Elements, Implications of Strategy Elements, Policies, Strategy Analysis, Communicating the Strategy. **Unit III:** Change Management for PLM: Configuration management, cost of design changes, schemes for concurrent engineering, Design for manufacturing and assembly, robust design, failure mode and effect-analysis. **Unit IV:** Modeling, Current Concepts: part design, sketching, use of datum's construction features, free ovulation, pattering, copying, and modifying features, reference standards for datum specification, Standards for Engineering data exchange. **Unit V:** Tolerance Mass Property Calculations: rapid prototyping and tooling, finite modeling and analysis, general procedure, analysis techniques. **Unit VI:** Finite Element Modeling: Applicability of FEM, Static analysis, thermal analysis, dynamic analysis
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 540	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Elective			
Course of title	Advanced Mechanism Design			
Course Coordinator				
Course objectives:	To gain knowledge of advanced mechanisms and design considerations			
Course outcomes	CO1: Student will Compute mobility and motion parameters. CO2: Apply Hall and Ault‟s method, Goodman‟s indirect method and Chase solution CO3: Student will Design two- and three- position synthesis & apply Chebychev spacing; describe cognate linkages. CO4: Student will analyze forces on static and dynamic mechanisms.			

Semester	Autumn:		Spring:		
	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				
Text Books:					
	Advanced Mechanism Design: Analysis and Synthesis Vol. II, Sandor and Arthur G. Erdman, Elsevier				
Reference Book:					
	Advanced Theory of Mechanisms and Machines, M.Z. Kolovsky and A.N. Evgrafov, Elsevier				

Content	**Unit I:** **Introduction:** Concepts related to kinematics and mechanisms, Degrees of freedom, Grubler's Criteria, Transmission and Deviation angles, Mechanical advantage. **Unit II:** **Kinematic Synthesis**: Type, number and dimensional synthesis, Spacing of accuracy points, Chebyshev polynomials, Motion and function generation, Graphical synthesis with two, three and four prescribed motions and points, The complex number modeling in kinematic synthesis, The Dyad, Standard form, Freudentein's equation for three point function generation coupler curves, Robert's law, Cognates of the slider crank chain. **Unit III:** **Path Curvature Theory**: Fixed and moving centrode, Inflection points and inflection circle circle, Euler'-savary Equation, Bobillier's and Hartsman construction. **Unit IV:** **Dynamic Force Analysis:** Introduction, Inertia force in linkages, Kineto static analysis by superposition and matrix approach, Time response of mechanisms, Force and moment balancing of linkages. **Unit V:** **Spatial Mechanism:** Introduction to 3-dimensional mechanisms, Planar Finite, Rigid body and spatial transformation, Analysis of spatial
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 584	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Elective			
Course of title	Advanced Finite Element Method			
Course Coordinator				
Course objectives:	Introduction to plates and shells theory. To apply finite element method for non linear and structural dynamic problem			
Course Outcomes	CO1: Understand the concepts behind formulation methods in FEM. CO2: Identify the application and characteristics of FEA elements. CO3: Error Estimates and Adaptive Refinement & Develop element characteristic equation. CO4: Governing Equations of Fluid Mechanics and Heat Transfer.			
Pos				
Semester	Autumn:		Spring:	
	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				
Text Books:				
	Advanced Finite Element Method in Structural Engineering, Ian Gibson and David Rosen, Elsevier			
Reference Book:				

	Advanced Topics in Finite Element Analysis of Structures: With Mathematics and MATLAB Computations, Douglas Bryden, Elsevier
Content	**Unit I:** Bending of Plates and Shells: Review of Elasticity Equations, Bending of Plates and Shells, Finite Element Formulation of Plate and Shell Elements, Confirming and Non- Confirming Elements, Co and C1 Continuity Elements, Application and Examples. **Unit II:** Non-Linear Problems: Introduction, Iterative Techniques, Material, Non-Linearity, Elasto-Plasticity, Plasticity, Visco-Plasticity, Geometric Non-Linearity, Large Displacement Formulation, Application in Metal Forming Process, Contact Problems. **Unit III:** Dynamic Problem: Direct Formulation, Free, Transient and Forced Response, Solution Procedures, Subspace Iterative Technique, Houbolt Wilson and New Mark Methods, Examples. **Unit IV:** Error Estimates and Adaptive Refinement: Error Norms and Convergence Rates, -h Refinement with Adaptivity, Adaptive Refinement. **Unit V:** Fluid Mechanics and Heat Transfer: Governing Equations of Fluid Mechanics, In Viscid and Incompressible Flow Potential Formulations, Slow Non-Newtonian Flow, Metal and Polymer Forming, Navier Strokes Equation, Steady and Transient Solution.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: MELM 581	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	Theory			
Course of title	Robotics			
Course Coordinator				
Course objectives:	The objective of this course is to introduce the basic concepts in Robotics The course will illustrate the robot kinematics, sensors, effectors, control systems, and briefly discuss robot application in industry.			
Course Outcomes	CO1: Basic components of robot system, functions and specifications CO2: Perform kinematic analysis for various Robotic configurations. CO3: Develop dynamic models for various Robotic configurations. CO4: Control of industrial manipulators.			
Pos				
Semester	Autumn:		Spring:	

	Lecture	Tutorial	Practical	Credits	Total Teaching load
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	Nil				
Prerequisite credits	Nil				
Equivalent course codes as per the proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:		
1	Title	Principles of Robot Motion: Theory, Algorithms, and Implementations
	Author	Howie Choset and Kevin M. Lynch
	Publisher	Elsevier

Reference Book:		
1	Title	Introduction to Robotics: Analysis, Control, Applications
	Author	Saeed B. Niku
	Publisher	Elsevier
	Edition	1st Edition
Content		

Unit I:

Fundamentals of Robots: Introduction to Robotics, major component so a robot, robotic like devices, classification of robots – Classification by coordinate system and by control method, Basic components of robot system, functions and specifications of robot, fixed versus flexible automation, overview of robot application.

Unit II:

Robot end Effectors: Introduction, end effectors, interfacing, types of end effectors, grippers and tools, considerations in the selection and design of remote-centered devices.

Unit III:

Actuators: Types, Characteristics of actuating system: weight, Power-to-weight ratio, Operating pressure, Stiffness vs. Compliance, Use of reduction gears, Comparison of hydraulic, Electric, pneumatic, actuators, Hydraulic actuators, Proportional feedback control, Electric Motors: DC motors, Reversible AC motors, Brushless DC motors, Stepper motors- structure and principle of operation, Stepper motor speed-torque characteristics.

Unit IV:

Sensors: Sensor characteristics, Position sensors-potentiometers, Encoders, LVDT, Resolvers, Velocity sensor-encoders, tachometers, Force and Pressure sensors – piezoelectric, force sensing resistor, Torque sensors, Touch and tactile sensor, Proximity sensors-magnetic, Optical, Ultrasonic, Inductive, Capacitive, Eddy-current proximity sensors.)

Unit V:

Robot Kinematics: Robots as a mechanism, Matrix representation of point, vector in space, representation of frame at origin and in the reference frame. Homogeneous transformation Matrices, Representation of transformations – pure translation, pure rotation, combined transformations.

	Forward solution – Denavit Hartenberg procedure. Problems on simple 2R and 3R manipulator, Puma manipulators, SCARA manipulator, Inverse or backward solution – techniques, problems involved of 2R, 3R manipulators. **Unit VI:** Velocity and Statics of Manipulators: Differential relationships, Jacobian, Differential motions of a frame (translation and rotation), Linear and angular velocities of links in serial 2R manipulators Jacobian of serial manipulator, Singularities. Dynamics of Manipulators: Equation of motion of 2R manipulators using Lagrangian, Newton-Euler formulation. Introduction to trajectory planning, basics of trajectory planning
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%