SIPNA COLLEGE OF ENGINEERING & TECHNOLOGY, AMRAVATI

An Autonomous Institute Affiliated to

Sant Gadge Baba Amravati University, Amravati, Maharashtra (India)

(Approved by AICTE, New Delhi and Recognized by DTE, Maharashtra)

(Accredited With 'A+' Grade by NAAC)

Master of Technology (M. Tech.)

Syllabus - Semester I and Semester II

Department of Mechanical Engineering

M. Tech. Mechanical (Computer Integrated Manufacturing)

(Semester Pattern)

Effective from Academic Year 2024-25

Prepared by: Board of Studies - Mechanical Engineering

Approved by: Academic Council - Sipna COET, Amravati

			31/08/2024	1.00
Chairman Board of Studies	Dean Academics	Chairman Academic Council	Date of Release	Version

Syllabus Semester I

Program:	M.Tech. Mechanical (CIM)			Semester:			I
Course:	Computer Applications in Design			Code:			MTMEPC01ME1T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	0	3	3	20	20	60	100

Methods of Teacher Assessment (TA): Attendance, Viva, Group Discussions, Assignments

Course Objectives:

- To develop a general understanding of fundamental CAD concepts.
- To impart the parametric fundamentals to create and manipulate geometric models using curves,surfaces and solids.

Course-outcomes: After completion of the course, the students will be able to:

CO	Course Outcomes	BT Level (L1 to L6)
1	Understand CAD systems for implementing	L2
2	Develop confidence for self-education and creativity knowledge in their field of Engineering.	L3
3	Understand the different methods of solid modelling.	L2
4	Interpret the parametric relation based solid models.	L2
5	Demonstrate the different approaches for assembly of parts.	L2
6	Apply geometric transformations on the created wire frame, surface and solid model.	L3

Unit I: Fundamentals of Computer Graphics	**(Hrs. 06)**
Introduction to computer technology and functions of a graphics package, benefits of CAD. Windowing view ports, 2-D & 3-D transformation (Translation, scaling, rotation). Output primitives (points, lines, curves etc.).	
Unit II: Curves and Surfaces Modeling	**(Hrs. 06)**
Introduction to curves - Analytical curves: line, circle, synthetic curves: Hermite cubic, spline- Beziercurve and B-Spline curve. Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution andtabulated cylinder, synthetic surfaces: Hermite bi-cubic surface, Bezier surface and B-Spline surface.	
Unit III: Solid Modeling	**(Hrs. 06)**
Sweep representations - boundary representations – constructive solid geometry - comparison of representations - user interface for solid modeling.	
Unit IV: Graphic Fidelity	**(Hrs. 06)**
Hidden Line, Surface – solid shading/coloring. Introduction to parametric and variational geometry basedsoftware's and their principles creation of prismatic parts using these packages.	
Unit V: Assembly of Parts and Simulation.	**(Hrs. 06)**
Assembly modeling - interference of positions and orientation, mechanism simulation.	
Unit VI: Product Data Exchange	**(Hrs. 06)**
Types of file formats & their exchange, Data Exchange standards – IGES, STEP etc–Communicationstandards.	
Total Lecture	**36 Hours**

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Textbooks:	
1.	David F. Rogers, James Alan Adams "Mathematical elements for computer graphics"second edition, Tata McGraw-Hill edition.2003
2.	Computer Aided Design in Mechanical Engineering by V.Ramamurti
3.	CAD/CAM by Groover and Zimmers.

Reference Books:	
1.	Foley, Wan Dam, Feiner and Hughes – Computer graphics principles & practices,Pearson Education – 2003.
2.	Ibrahim Zeid Mastering CAD/CAM – McGraw Hill, International Edition, 2007.
3.	William M Neumann and Robert F.Sproull "Principles of Computer Graphics", McGraw HillBook Co. Singapore, 1989.
4.	Donald Hearn and M. Pauline Baker "Computer Graphics", Prentice Hall, Inc., 1992.

MOOCs Links and additional reading, learning, video material	
1.	https://www.youtube.com/watch?v=U9NrXOBXA1I&list=PLWPirh4EWFpHukXICQrDcmjZUa2WILMAb

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Program:	M. Tech. Mechanical (CIM)			Semester:			I
Course:	Computer Aided Manufacturing			Code:			MTMEPC02ME1T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	-	3	3	20	20	60	100

Methods of Teacher Assessment (TA): Attendance/classroom presentations/assignments/group discussion

Course Objectives: The students are expected to be knowledgeable in Engineering product specification, CAD/CAM integration, CNC machine tool building, CNC programming using manual method, generation of CNC codes using CAM software.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Compare different types of automation using fundamental of CAM and Automation.	L4
2	Differentiate between different graphic interfaces	L2
3	Differentiate between different interpolation techniques.	L2
4	Develop a CNC part program by applying various features, such as cutter radius offset, subprogram,mirror, canned cycles, and pocket cycles, of machining centre to reduce programming task.	L3
5	Develop a CNC part program using APT commands	L3
6	Illustrate concept of Group Technology and Flexible Manufacturing system.	L2

Unit I: Introduction To CAM **(6 Hrs.)**

The evolution of product realization, CAM and its historical development, History of various NC machines like NC, CNC and DNC machines, Product cycle and scope of CAD/CAM/CIM in product cycle, Need of NC technology, Elements of CNC machines, advantages of NC technology over conventional manufacturing, Various CNC applications in different industries.

Unit II: NC/CNC Machine Tools **(7 Hrs.)**

Networking- networking techniques, network interface cards, Graphics standards – Data exchange format, evolution- features of various interfaces GKS, IGES, DXF, PDES, STEP etc., Process planning, Computer Aided Process Planning(CAPP) - variant, generative approaches.

Unit III: CNC Control System and Machine Tools **(7 Hrs.)**

CNC motion controller, Linear, circular, helical interpolator, Positioning and contouring control loops, MCU, adaptive control system, CNC machining centre, turning, grinding, EDM, wire EDM, boring, turn mill and CNC gear cutting.

Unit IV: Part Programming For CNC Machines **(6 Hrs.)**

Structure of CNC program, Coordinate systems, G & M codes, Tool zero presetting, cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, sub routines, do loop,mirroring features, Manual part programming for CNC turning and machining centre for popular controllers like Fanuc, Siemens, Generation of CNC program using CAM software.

Unit V: Automatically Programmed Tools (APT) **(5 Hrs.)**

Introduction to APT, geometry and motion statements, programming for geometry, drill cycles, and hole pattern.

Unit VI: Application Of Computer Integrated Manufacturing (CIM) Systems **(6 Hrs.)**

Concept and terminology, Part family formation, Classification and coding systems for components, Group technology machine cells. Group technology applications for computer integrated manufacturing

Total Lecture **37 Hours**

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Textbooks:	
1.	D. Kochan-" CAM Develop mention computer integrated Manufacturing, "Springer Verlag, Berlin
2.	"Mechatronics", HMT, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
3.	Rao, P.N., "CAD/CAM", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2010.
4.	Singh, N., "Systems Approach to Computer-Integrated Design and Manufacturing", Wiley India Pvt. Ltd.,2011.
5.	Yoram Koren- "Computer control of manufacturing", Mc-Graw Hill.
6.	Groover, M.P., "Automation, Production systems and Computer Integrated Manufacturing", Pearson Education Asia (2009).

Reference Books:	
1.	Chang, T.C., Wysk, R.A. and Wang, H.P., "Computer Aided Manufacturing", Pearson Prentice Hall, 2009.
2.	Jones, B.L., "Introduction to Computer Numerical Control", Pitman, London, 1987.
3.	Seamers, W.S., "Computer Numeric Control", Fourth Edition – Thomson Delmar, 2002.

MOOCs Links and additional reading, learning, video material	
1.	CAD/CAM Computer Aided Design / Computer Aided Manufacturing (https://onlinecourses.swayam2.ac.in/nou24_me10/preview)
2.	Computer numerical control CNC of machine tools and processes (https://onlinecourses.nptel.ac.in/noc19_me46/preview)
3.	Automation In Production Systems and Management (https://onlinecourses.nptel.ac.in/noc24_mg117/preview)

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Program:	M. Tech. Mechanical (CIM)			Semester:			I
Course:	Computer Assisted Production Management			Code:			MTMEPC03ME1T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
03	-	03	03	20	20	60	100

Methods of Teacher Assessment (TA): Attendance, Assignments, Viva, Group Discussion

Course Objectives: This course aims to

1. Provide an overview of production management through Computer Aids.
2. Familiarize the student with the knowledge of Computer Assisted Production Management.
3. Focusing on the computer aided tools applicable in managing Automated production, Material ResourcePlanning & Enterprise Resource Planning.
4. Holistic approach to improve and increase the value of Computer Aided tools in Production Management.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Explain the Computer Aided Production Management concepts.	L2
2	Apply the knowledge of part representation methods for representing the basic parts.	L3
3	Demonstrate the Concept of Material Requirement Planning (MRP).	L2
4	Illustrate Inventory Management system.	L2
5	Identify various methods of Forecasting.	L2
6	Outline the concept of Enterprise Resource Planning (ERP).	L6

Unit I: Concept of Computer Aided Production Management (CAPM)	**(05 Hrs.)**
Introduction of Production Management, Computer Aided System concept, Hierarchical structure, System design, Decision making procedure, Manufacturing Systems, Factors affecting selection of Manufacturing Process, Modes of Production.	
Unit II: Computer Aided Process Planning (CAPP)	**(06 Hrs.)**
Approaches to CAPP, basic part representation methods, shape producing capabilities, Process economics.Capacity planning, its need and different methods, Role of Capacity planning in manufacturing, planning and control systems	
Unit III: Concept of Material Requirement Planning (MRP)	**(07Hrs.)**
Material Requirement: Terminology, Types of Demands, Inputs to MRP, Techniques of MRP, Lot sizing methods, Advantages and disadvantages of MRP, basics of Manufacturing Resources Planning (MRP –II).	
Unit IV: Computer Aided Inventory Control	**(06 Hrs.)**
Importance of Inventory and inventory management, Inventory management systems, Computer aided purchasing procedure, simulation of inventory problems.	
Unit V: Computer Aided Forecasting	**(07 Hrs.)**
Various methods, Comparison of various methods and suitability to different products, Use of computer indemand forecasting. Aggregate Planning: Performance measures, Qualitative and quantitative methods.	
Unit VI: Enterprise Resource Planning (ERP)	**(07 Hrs.)**
Introduction, Main features, Generic model of ERP system, Selection of ERP, Proof of concept approach, Analytic hierarchy approach, ERP implementation.	
Total Lecture	**38 Hours**

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Textbooks:	
1.	An Introduction to Computer Aided Production Management, Childe, S., Springer
2.	Computer Aided Production Management, Mahapatra P B, PHI
3.	Production & Operations Management: Concepts, Models and Behaviour, Adam E. (Jr.), Ebert R J., PHI
4.	Production Planning and Inventory Control, N.S.L. Mc Leavey, D.W. & P. J. Billigton, PHI Publisher
5.	Textbook of Enterprise Resource Planning, Mahadeo Jaiswal & Ganesh Vanapalli, Laxmi Publications

Reference Books:	
1.	Production Systems Planning Analysis and Control, J.L. Riggs, John Wiley & Sons
2.	Production & Operations Management, Nair G N, McGraw-Hill.
3.	Systems Approach to Computer Integrated Design and Manufacturing, Singh Nanua, John Wiley & SonsNew York.
4.	Production & Operations Management, Chary S N, McGraw-Hill

MOOCs Links and additional reading, learning, video material	
1.	https://nptel.ac.in/courses/112/104/112104188/
2.	https://onlinecourses.swayam2.ac.in/nou24_ce04/preview
3.	https://onlinecourses.nptel.ac.in/noc24_mg117/preview

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Program:	M. Tech. Mechanical (CIM)			Semester:		I
Course:	Computer Application in Design Lab			Code:		MTMEPC04ME1P
Teaching Scheme				Evaluation Scheme		
Practical	Tutorial	Hours	Credit	INT	EXT	Total
2	-	2	1	30	20	50

Course Objectives:

1. Introduction to CAD and its role in the industry.
2. Study of algorithms for displaying line.
3. To simulate geometric transformation.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Understand & utilize applications of CAD Software.	L2
2	Create solid models of components using the advanced solid modeling tools.	L6
3	Assemble the solid components using the assembly modeling tools and prepare the product drawing /drafting. Also simulate the assembly using a simulate tools.	L6

General Guidelines: Conduct at least five practicals based on the syllabus.

Expt. No.	List of Experiments
1	To study line generating digital different analyzer (DDA) algorithm.
2	To study Bresenhum's circuit algorithm.
3	To study geometric transformation.
4	Prepare 2D drawing using Auto CAD.
5	Study of graphic package for computer aided drafting CATIA / Creo / FUSION 360 and also draw gear using CATIA/Creo / FUSION 360 software.
6	Generate 3-D model sketch using CATIA / Creo / FUSION 360 CAD software.
7	Prepare assembly model using CATIA / Creo/ FUSION 360 CAD software.
8	Develop simulation of assembly model using CATIA / Creo/ FUSION 360 CAD software.

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Program:	M. Tech. Mechanical (CIM)			Semester:			I
Course:	Mechatronics			Code:			MTMEPE01ME1T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	0	3	3	20	20	60	100

Methods of Teacher Assessment (TA): Attendance, Viva, Group Discussions, Assignments

Course Objectives: To provide the student with the knowledge of sensors, transducers, various types of actuators used in Mechatronics systems and also the use of PLCs and Mechatronics design.

Course-outcomes: After completion of the course, the students will be able to:

CO	Course Outcomes	BT Level (L1 to L6)
1	Understand mechatroics systems for implementing	L2
2	Interpret the functioning of sensors and signal processing.	L2
3	Adopt the knowledge of PLC and implementation of real life system	L6
4	Demonstrate the use of actuators.	L2
5	Use the precise control valves to develop the circuit.	L3
6	Adopt the skill to develop the circuits for various industrial applications	L6

Unit I: Basics of Mechatronics	**(06 Hrs.)**
Definition and concept of mechatronics, comparison between traditional system and mechatronics system, key elements of mechatronics system, need and role of mechatronics in automation industry.	
Unit II: Sensors and Signal Processing	**(07 Hrs.)**
Introduction of sensors and its selection criteria, Working and application of types of sensor- Temperaturesensor, Speed & position measurement, tactile sensor, Micro sensor etc. Data acquisition process and its key parameters, A/D converter, D/A converter and its types.	
Unit III: Electromechanical system	**(07 Hrs.)**
PLC introduction and its architecture, life cycle of PLC. Programming Language for PLC, review of logic gateand logic system, flip - flop criteria for actuators different types of actuators and its applications mechanical, electrical, hydraulic, and p and its application, design of basic logic networks.	
Unit IV: Actuators	**(05 Hrs.)**
Introduction of actuators, selection criteria of actuators for pneumatic and hydraulic Circuit.	
Unit V: Control Valve and Accumulator	**(05 Hrs.)**
Concept of control valve, function and types of direction control valve, pressure control valve and flow control valve. Introduction of accumulator, its type and selection criteria.	
Unit VI: Hydraulic and Pneumatic Circuit	**(08 Hrs.)**
Important elements of hydraulic and pneumatic system, types of circuit, operation and its applications, prepare and investigate the different type of hydraulic and pneumatic systemused in industry, ANSI Symbol.	
Total Lecture	**38 Hours**

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Textbooks:	
1.	Introduction to Mechatronics and Measurement systems- 2/e by Aciatore and M. B. Histant, TataMcgraw Hill edition.
2.	Pneumatic and Hydraulics by H. L. Stewart.
3.	Mechatronics Bolton, W. Pearson education, second edition, fifth Indian Reprint, 2003

Reference Books:	
1.	Introduction to Mechatronics by Appus Kuttan K.K. - Oxford University Press.
2.	Mechatronics – A multidisciplinary approach 4/e by W.Bolton- Pearson Publication,
3.	Automation, Production systems and CIM by M. P. Groover- Pearson Publication.

MOOCs Links and additional reading, learning, video material	
1.	https://onlinecourses.nptel.ac.in/noc21_me27/preview#:~:text=This%20course%20will%20cover%20all,response%20and%20design%20and%20mechatronics.&text=Category%20%3A,Manufacturing%20Processes%20and%20Technology

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Program:	M. Tech. Mechanical (CIM)			Semester:	I	
Course:	Mechatronics Lab			Code:	MTMEPE02ME1P	
Teaching Scheme				Evaluation Scheme		
Practical	Tutorial	Hours	Credit	INT	EXT	Total
2	-	2	1	30	20	50

Course Objectives:

- Understand concept of transfer function, reduction and analysis
- Understand principles of sensors, its characteristics, interfacing with micro-controller
- Understand the concept of PLC system and its ladder programming, and significance of PLC systems in industrial application.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Identification of key elements of mechatronics system and its representation in terms of block diagram.	L3
2	Understanding the concept of signal processing and use of interfacing systems such as ADC, DAC, digitall/O .	L2
3	Asses the Sensors and Actuators using appropriate micro-controller.	L5
4	Development of PLC ladder programming and implementation of real life system.	L3

General Guidelines: Conduct at least five practicals based on the entire syllabus.

Expt. No.	List of Experiments
	At least conduct five practicals from the list
1	Study of pneumatic system
2	Study applications of sensors and actuators
3	Study of pick & Place robot.
4	Study of batch processing reactor
5	Study of digital to analog converter
6	Study of PLC and implementation of real life system.
7	Study of control valves.
8	Study of D.C. motor control unit.
9	Traffic Light Control System (Simulation)

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Program:	M. Tech. Mechanical (CIM)			Semester:			I
Course:	Design for Manufacturing			Code:			MTMEPE03ME1T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	0	3	3	20	20	60	100

Methods of Teacher Assessment (TA): Attendance, Viva, Group Discussions, Assignments

Course Objectives: To apply the design for manufacturing principles in casting, welding, forming, machining and assembly, by considering various manufacturing constraints.

Course Outcomes: After completion of the course the students will be able to:

CO	Course Outcomes	BT Level (L1 to L6)
1	Understand the economics of manufacturing	L2
2	Interpret consideration of manufacturing parameters for designing of casting, welding component.	L2
3	Demonstrate design skill to overcome difficulties in manufacturing of formed metal components.	L2
4	Design plastic component considering manufacturing process and strength aspects.	L6
5	Develop machined component using in-house machining facilities.	L3
6	Evaluate assembly process to reduce cost, cycle time using software.	L5

Unit I: Introduction	**(6Hrs.)**
Economics of Process selection – General design principles of Manufacturability – Material selection – Considering Strength and Manufacturing	
Unit II: Casting Design And Weldment Design	**(6Hrs.)**
Factors affecting casting design- Strength aspects Sand casting and die casting designFactors affecting weldment design-Gas and arc welding design.	
Unit III: Formed Metal Components	**(6 Hrs.)**
Design considerations for the manufacture of extruded, cold headed metal parts – Tube and section bends	
Unit IV: Plastic Component Design	**(6Hrs.)**
Design considerations for the manufacture of Thermo setting plastic parts-Reinforced – Plastic/Composite parts	
Unit V: Machined Components Design	**(7 Hrs.)**
Design considerations for the manufacture of turned parts-drilled parts-milled parts, planned, shaped andslotted parts-Ground parts-parts produced by EDM.	
Unit VI: Design For Assembly	**(7 Hrs.)**
Types of assembly – evaluation of assembly – assembly cost reduction – impact on quality – related softwareusage – case studies.	
Total Lecture	**38 Hours**

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Textbooks:	
1.	Molloy, O., E. A. Warman, and S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Kluwer, 1998.
2.	Peck, H., "Designing for manufacture", Sir Isaac Pitman & Sons Ltd., 1973.
3.	Bralla, J.G.,"Handbook of product design for manufacture", McGraw Hill Book Co., 1986.

Reference Books:	
1.	K G Swift and J D Booker,Process selection: from design to manufacture, London: Arnold, 1997.
2.	Chang,T.C., Wysk,R.A. and Wang, H.P.,"Computer-Aided Manufacturing", Second Edition, Prentice Hall, 1998.
3.	M FAshby and K Johnson, Materials and Design - the art and science of material selection in product design,Butterworth-Heinemann, 2003.

MOOCs Links and additional reading, learning, video material	
1.	https://archive.nptel.ac.in/courses/112/101/112101005/
2.	https://ndl.iitkgp.ac.in/

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Program:	M. Tech. Mechanical (CIM)			Semester:		I
Course:	Design for Manufacturing Lab			Code:		MTMEPE04ME1T
Teaching Scheme				Evaluation Scheme		
Practical	Tutorial	Hours	Credit	INT	EXT	Total
2	0	2	1	30	20	50

Course Objectives:

- To develop concept of design for manufacturing (DFM).
- To develop concept of design for assembly (DFA).

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Design casting component considering DFM	L6
2	Design welding component considering DFM.	L6
3	Design forging component considering DFM.	L6
4	Design moulding component considering DFM.	L6
5	Design machining component considering DFM.	L6
6	Identify feature in any component considering DFA.	L3

General Guidelines: Conduct any four practicals based on the syllabus.

Pract. No.	List of Practical
1	Identify features difficult to manufacture and redesign the casting component using DFM approach.
2	Redesign welding component using DFM approach.
3	Identify features difficult to manufacture and redesign the forging component using DFM approach.
4	Identify features difficult to manufacture and redesign the moulding component using DFM approach
5	Estimate tolerances and surface finish values for machined component using DFM approach.
6	Perform an exercise to identify features (self-locating, self-fastening, minimize orientation during assembly, retrieval, handling and insertion, symmetry) for assembly of a component.

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Program:	M. Tech. Mechanical (CIM)			Semester:			I
Course:	Advances In Manufacturing Technology			Code:			MTMEPE05ME1T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	0	3	3	20	20	60	100

Methods of Teacher Assessment (TA): Attendance, Viva, Group Discussions, Assignments

Course Objectives: The students are introduced to unconventional machining processes, composite manufacturing and rapidprototyping.

Course Outcomes: After completion of the course the students will be able to

CO	Course Outcomes	BT Level (L1 to L6)
1	Understand concept of abrasive machining, effect of various parameter on machining process.	L2
2	Interpreted concept of chemical machining, effect of various parameter on machining Process.	L2
3	Explain thermal machining process and various governing parameter.	L2
4	Understand electron beam machining and machining parameter.	L2
5	Develop the concept of composite manufacture.	L3
6	Demonstrate Rapid prototype Processes.	L2

Unit I: Abrasive Machining **(7 Hrs.)**

Ultrasonic Machining: -elements of the process of UM, mechanics of material removal, Process parameters and their effect on machining process, applications and limitations.
Abrasive water jet machining: - elements of the process of AWJM, mechanics of material removal, Process parameters and their effect on machining process, applications and limitations.

Unit II: Chemical Machining **(6 Hrs.)**

Electro Chemical Process: - basic fundamentals of Electro Chemical grinding, metal removal rate in ECM, Tooling, process parameters and their effect on machining process and applicatfons.
Chemical Machining: - basic fundamentals of CM, principle of material removal-maskants-elements , Process parameters and their effect on machining process, Advantages and applications of CM.

Unit III: Thermal Machining **(6 Hrs.)**

Basic principle of spark erosion (EDM), wire cut EDM & Electric discharge grinding process, principle of workingand applications, Various process parameters and their effects on machining.

Unit IV: Electron Beam Machining **(6 Hrs.)**

Electron Beam Machining: - generation and control of EBM for machining, theory of EBM, applications andlimitations. Laser Beam Machining: process description, mechanism of material removal in LBM, process parameters, applications and limitations.

Unit V: Composite Materials **(7 Hrs.)**

Introduction to composites materials: Function of Fibres & Matrix, classification of composites.
Manufacturing methods: Spray Lay-up, Wet/Hand Lay-up, Vacuum bagging, Resin transfer moulding (RTM), Resin Film infusion and applications of composites.

Unit VI: Rapid Prototyping Method **(6Hrs.)**

Study of RP relevance in precision manufacturing, Sterolithography , Fused deposition methods, principle of prototyping and its various applications .

Total Lecture Hours 38

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Textbooks:	
1.	Advanced machining process ,V.K.Jai, Allied publishers
2.	Modern machining process, Pande P.C. & Shah H.S.Tata Mc-Graw Hills.
3.	Manufacturing Technology, Volume-II, Rao P.N., Tata Mc-Graw Hills.

Reference Books:	
1.	Principles of Modern Manufacturing, Mikell P. Groover, SI version, Wiley India Edition.
2.	Manufacturing Technology, Kalpakzian, Pearson.
3.	Non-Conventional Machining, Mishra P.K.,Narosa Publisher, New Delhi.
4.	Composite Materials –production, properties, testing and applications, K.Shrivasan, Narosa Pubications,

MOOCs Links and additional reading, learning, video material	
1.	https://archive.nptel.ac.in/courses/112/107/112107078/
2.	https://ndl.iitkgp.ac.in/

APPROVED in 1st Academic Council Meeting
Dated:- 31/08/2024

Program:	M. Tech. Mechanical (CIM)			Semester:		I
Course:	Advances in Manufacturing Technology Lab			Code:		MTMEPE06ME1P
Teaching Scheme				Evaluation Scheme		
Practical	Tutorial	Hours	Credit	INT	EXT	Total
2	0	2	1	30	20	50

Course Objectives:

- To understand the basic principle of material removal in various manufacturing process such as EDM, EBM, UM,CM etc,.
- To fabricate Rapid prototype and composite material component.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Create component using EDM.	L6
2	Build component on 3D printer.	L6
3	Construct composite material components.	L3
4	Demonstrate concept of material removal in chemical machining.	L2
5	Understand effects of various machining parameters on MRR in laser machining.	L2
6	Understand effects of various machining parameters on MRR in ultrasonic machining.	L2

General Guidelines: At least 4 practicals to be conducted based on the syllabus.

Pract. No.	List of Practical
1	To cut complicated profile on metal plate using EDM.
2	To develop any prototype component on 3D printer.
3	To create composite material part using hand lay-up technique.
4	To remove material from surface using principal of chemical machining.
5	Study of effects of various machining parameters on MRR in laser machining.
6	Study of effects of various machining parameters on MRR in ultrasonic machining.

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Dated:-...31/08/2024.....

Program:	M. Tech. Mechanical (CIM)			Semester:			I
Course:	Concurrent Engineering			Code:			MTMEPE07ME1T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	-	3 Hours	3	20	20	60	100

Methods of Teacher Assessment (TA): Attendance, Viva, Group Discussions, Assignments

Course Objectives:

- To make the students aware on the importance, concept, tools and techniques of concurrent engineering
- To introduce Concurrent Engineering Principles applied to manufacturing sectors and design stage.
- To study the concept of automated fabrication system.
- To learn about concurrent mechanical design.
- To understand the difficulties associated with concurrent engineering.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Understand the need of concurrent engineering and strategic approaches for product design.	L2
2	Apply concurrent design principles to manufacturing system.	L3
3	Apply concurrent design principles to product design.	L3
4	Interpret the need concurrent automated fabrication system.	L2
5	Develop concurrent mechanical design.	L3
6	Evaluate the difficulties associated with implementation of concurrent engineering.	L5

Unit I: Introduction	**6 (Hrs.)**
Introduction: Concurrent engineering concepts, sequential versus concurrent engineering, importance of concurrent engineering, benefits of concurrent engineering.	
Unit II: Concurrent Engineering in Manufacturing	**6 (Hrs.)**
Concurrent engineering approach in manufacturing systems: System design procedure, features, assembly resource alternatives, tasks assignments	
Unit III: Design Stage	**6 (Hrs.)**
Life-cycle design of products, opportunity for manufacturing enterprises, modality of Concurrent Engineering Design, Automated analysis idealization control , Concurrent engineering in optimal structural design , Real time constraints.	
Unit IV: Concurrent Automated Fabrication Systems	**6 (Hrs.)**
Introduction, methodology, preliminary and details work content analysis, human resource considerations, 'Technical Economic' performance evaluation.	
Unit IV: Concurrent Mechanical design	**6 (Hrs.)**
Concurrent mechanical design, decomposition in concurrent design, negotiation in concurrent engineeringdesign studies, product realization taxonomy, plan for Project Management on new product development,bottleneck technology development.	
Unit VI: Implementation and Case Studies	**6 (Hrs.)**
Difficulties associated with performing concurrent engineering, life cycle costing, and case studies.	
Total Lecture	**36 Hours**

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Textbooks:	
1.	J.L. Nevines and D.E. Whitney-Concurrent Design of Products and Processes.
2.	Concurrent Engineering: Automation Tools and Technology by Andrew Kusaik, Wiley John and Sons Inc., 1992

Reference Books:	
1.	Integrated Product Development by Anderson MM and Hein, L. Berlin, Springer Verlog, 1987
2.	Design for Concurrent Engineering by Cleetus, J.Concurrent Engineering Research Centre, Morgantown W V, 1992.

MOOCs Links and additional reading, learning, video material	
1.	https://onlinecourses.nptel.ac.in/noc23_me26/preview

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Program:	M.Tech. Mechanical (CIM)			Semester:			I
Course:	Management Information Systems			Code:			MTMEPE08ME1T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	-	3	3	20	20	60	100

Methods of Teacher Assessment (TA): Attendance, Viva, Group Discussions, Assignments

Course Objectives:

- To make students understand that how MIS can provides the data to identify non-performing areas
- How to use MIS for better business productivity and efficiency, better communication
- Using MIS in decision making
- To get better knowledge of customer needs.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Recognize the importance of information system	L2
2	Explore the link between information system and MIS	L3
3	Identify the application of MIS in decision support	L2
4	Understand the role of BI in MIS	L2
5	Identify the requirement of IT infrastructure for MIS	L2
6	Understand the importance of information security	L2

Unit I: Management Information Systems (MIS) **(6 Hrs.)**

Perspectives on Information Systems, Nature and scope of MIS, Characteristics of MIS, Need and Role of MIS, Impact of MIS, functions and future of MIS, MIS: A support to the management, MIS: organization effectiveness, MIS for a digital firm

Unit II: Information System and MIS **(7 Hrs.)**

Organizations and Information Systems: Modern Organization, Information Systems in Organizations,Managing Information Systems in Organizations
Concepts of Management Information Systems: Data and Information, Information as a Resource, Information in Organizational Functions, Types of Information Technology, Types of Information Systems,Decision Making with MIS, Communication in Organizations.

Unit III: Decision Support System, Knowledge Management and Management of Global Enterprise **(7 Hrs.)**

Decision Support System(DSS), DSS Models, Group Decision Support System(GDSS), Knowledge based Expert System(KBES), Enterprise Resource Planning(ERP) System, ERP Model and Modules, Benefits of ERP, Supply Chain Management(SCM), Information Management in SCM, Customer Relationship Management(CRM)

Unit IV: Business Intelligence for MIS **(6 Hrs.)**

Business Intelligence and MIS, what is Business Intelligence (BI), Tools and Techniques of BI, why is BI Developed? How is BI used? Process of generation of BI, MIS and BI.

Unit V: Managing information and IT infrastructure **(7 Hrs.)**

Managing Information Systems and Information Technology Infrastructure
Managing Information System: Challenges of Managing the IT Function, Vendor Management, IT Governance, Information Technology Infrastructure and Choices: What is the IT Infrastructure?, IT Infrastructure Decisions, Infrastructure Components, Networks

Unit VI: Information Security **(6 Hrs.)**

Introduction, Threats and Vulnerability, Controlling Security Threat and Vulnerability, Managing SecurityThreat in E-Business, Measures of Information Security, Information Security Management.

Total Lecture **39 Hours**

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Textbooks:	
1.	James A. O' Brien, George M. Marakas: Management Information Systems, Global Mc-Graw Hill, 10thEdition, 2011, ISBN:978-0072823110.
2.	Steven Alter: Information Systems The Foundation of E-Business, Pearson Education, 4th Edition, 2002, ISBN:978-0130617736.
3.	W.S. Jawadekar: Management Information Systems, Tata McGraw Hill, 2006, ISBN: 9780070616349.
4.	Management Information Systems, Loudon and Loudon, 11th edition, Pearson.
5.	MIS: Managing Information Systems in Business, Government and Society, 2ed by Rahul De, Wiley

Reference Books:	
1.	Kenneth C. Laudon and Jane P. Laudon: Management Information System, Managing the Digital Firm,Pearson Education,14th Global edition, 2016, ISBN:9781292094007.

MOOCs Links and additional reading, learning, video material	
1.	Management Information System (https://onlinecourses.nptel.ac.in/noc24_mg96/preview)

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Program:	M. Tech. Mechanical (CIM)			Semester:			I
Course:	Virtual Manufacturing			Code:			MTMEPE09ME1T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	0	3	3	20	20	60	100

Methods of Teacher Assessment (TA): Attendance, Viva, Group Discussions, Assignments

Course Objectives: An understanding of basic principles, techniques and issues underlying geometric design, digital geometryprocessing, and the latest virtual prototyping and e-manufacturing solutions in design and manufacturing.

Course-outcomes: After completion of the course, the students will be able to:

CO	Course Outcomes	BT Level (L1 to L6)
1	Describe the principles and facilities for virtual reality	L2
2	Summarize the visualization of product in VM.	L2
3	Recognize the applications of VM in digital mock up.	L2
4	Demonstrate the use of CAD simulation software for manufacturing process.	L2
5	Describe the methods and algorithms for collaborative design and design a product assembly by utilizingappropriate collaborative design tools.	L2
6	Demonstrate the applications of VM in material processing through simulation.	L2

Unit I: Introduction virtual manufacturing:	**(Hrs. 06)**
Definitions, scope of Virtual manufacturing, methods and tools used in Virtual manufacturing, Paradigms of VM: Design - centered, Production – centered and Control centered VM. Generic VM Issues- relationships between VM, Virtual Prototyping. Role of object oriented technology in VM.	
Unit II: Product data visualization	**(Hrs. 07)**
Graphics fundamentals, graphics data representation, polygonal based operations, LOD management, lighting and coloring, illumination and shading. Virtual reality and its applications: computer animation, viewing in 3D, input / output devices, virtual and augmented reality, virtual design, virtual prototyping and virtual manufacturing.	
Unit III: Digital Mock-up Unit (DM) in Virtual Manufacturing	**(Hrs. 06)**
Integrated product and process development in collaborative virtual engineering environment using CAD software. Success factors for Digital Mock-ups (DMU) in complex aerospace product development.	
Unit IV: Manufacturing process simulation:	**(Hrs. 07)**
Factory level, Machine level, Component level, Process level. Integrated simulation method to support virtualfactory engineering. Application of virtual reality simulation of a mechanical assembly production line. Case studies using CAD simulation software.	
Unit V:Dispersed Network Manufacturing:	**(Hrs. 06)**
Virtual factory, enterprise collaborative modeling system, virtual manufacturing system, Web-based work flow management, collaborative product commerce, applications of multi-agent technology, e-supply chain management.	
Unit VI: Virtual Machining Simulation	**(Hrs. 06)**
STEP-NC based machining simulation . Advanced process simulation and NC program optimization software-simulate real-world performance of machining operations.	
Total Lecture	**38 Hours**

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Textbooks:	
1.	David F. Rogers, James Alan Adams, Mathematical elements for computer graphics secondedition, Tata McGraw-Hill edition.2003
2.	Computer Aided Design in Mechanical Engineering by V. Ramamurti
3.	CAD/CAM by Groover and Zimmers.

Reference Books:	
1.	Foley,Wan Dam, Feinerand Hughes-Computer graphics principles & practices, PearsonEducation - 2003.
2.	Ibrahim Zeid -Mastering CAD/CAM-McGraw Hill, International Edition, 2007.
3.	William M Neumann and Robert F. Sproull "Principles of Computer Graphics", McGraw Hill Book Co. Singapore, 1989.
4.	Donald Hearn and M. Pauline Baker "Computer Graphics", Prentice Hall, Inc.,1992.

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Program:	M.Tech. Mechanical (CIM)			Semester:	I		
Course:	Research Methodology			Code:	MTMERM01ME1T		
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	0	3	3	20	20	60	100

Methods of Teacher Assessment (TA): Attendance, Assignment, Quiz, Viva voce

Course Objectives: To equip students with the knowledge and tools to conduct systematic research in engineering and technology disciplines.

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

CO	Course Outcomes	BT Level (L1 to L6)
CO-1	Understand the fundamentals of research methodology and identify research problems.	2
CO-2	Apply different research designs and methodologies appropriate to engineering problems.	3
CO-3	Analyze data using appropriate statistical methods and tools.	4
CO-4	Evaluate research articles, hypotheses, and results from a critical perspective.	5
CO-5	Create comprehensive research reports and communicate findings effectively.	6
CO-6	Synthesize advanced research techniques to develop innovative solutions in engineering.	6

Unit I: Fundamentals of Research Methodology	**(6 Hrs.)**
Meaning of research, objectives of research, types of research, research approaches, significance of research, research method versus methodology, research process, criteria of good research and problems encountered by researchers in India.	
Unit II: Defining the Research Problem	**(6 Hrs.)**
What is the research problem? selecting the problem, necessity of defining the problem, techniques involved in defining a problem.	
Unit III: Research Design	**(6 Hrs.)**
Meaning of research design, need for research design, features of good design, research hypothesis, experimental and non-experimental hypothesis testing research and different research design.	
Unit IV: Data Collection	**(6 Hrs.)**
Introduction, experiments and survey, collection of primary data, collection of secondary data, selection of appropriate method for data collection.	
Unit V: Data Preparation and Statistics	**(6 Hrs.)**
Data preparation process: checking, editing, coding, classification, tabulation, graphical representation, cleaning and adjusting, measures of central tendency: mean median, mode, averages, Measure of dispersion: range, mean deviation and standard deviation, kurtosis and measures of relationship	
Unit VI: Interpretation and Report Writing	**(6 Hrs.)**
Meaning and techniques of interpretation, significance of report writing, steps in report writing, layout and types of research report, mechanics of writing a research report and precautions for writing research report.	
Total Lectures	**36 Hours**

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Textbooks:	
1)	C.R. Kothari, Gaurav Garg - Research Methodology: Methods and Techniques, 4th Edition, New Age International Publishers, 2019.ISBN: 978-9386649225

Reference Books:	
1)	Deepak Chawla, Neena Sondhi - Research Methodology: Concepts and Cases, 2nd Edition, Vikas Publishing House, 2011. ISBN: 978-9325955402
2)	Ranjit Kumar - Research Methodology: A Step-by-Step Guide for Beginners, 5th Edition, SAGE Publications, 2019. ISBN: 978-1526449900
3)	K. N. Krishnaswamy, Appa Iyer Sivakumar, M. Mathirajan - Management Research Methodology: Integration of Principles, Methods and Techniques, Pearson Education India, 2009. ISBN: 978-8177585636

MOOCs Links and additional reading, learning, video material	
1)	https://www.coursera.org/learn/research-methods

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Syllabus Semester II

Program:	M. Tech. Mechanical (C I M)			Semester:			II
Course:	Flexible Manufacturing System			Code:			MTMEPC05ME2T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	0	3	3	20	20	60	100

Methods of Teacher Assessment (TA): Assignments/ Viva/ Group Discussions/ Presentations

Course Objectives:

- To acquire knowledge concept of flexible manufacturing system.
- To apply the knowledge of group technology and FMS for the automation of industrial processes.
- To aware different FMS layouts.
- To learn about automated material handling system in industries.
- To design and analyze various FMS.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Apply the concepts advanced manufacturing to the development of FMS	L5
2	Develop Plan for Implementation of FMS by adapting GT & CM.	L3
3	Apply various types of AGVs & retrieval systems for respective storage systems.	L5
4	Identify various workstations, system support equipments like CMMs.	L2
5	Identify hardware and software components of FMS.	L2
6	Understand and analyze the Flexible Manufacturing system.	L1

Unit I: Overview of Flexible Manufacturing System	**(6 Hrs.)**
Need for FMS Introduction, Definition, Basic Component of FMS, Significance of FMS, General layout and configuration of FMS, Principle Objectives of FMS, Benefits and limitations of FMS, Area of Application of a FMS in Industry.	
Unit II: Group Technology & Cellular Manufacturing	**(6 Hrs.)**
Introduction, Definition, Reasons for Adopting Group Technology, Benefits of Group Technology, Obstacles to Application of GT. Part classification and coding system. Cellular Manufacturing: Description and Classifications, Cellular versus Flexible Manufacturing.	
Unit III: Automated Storage & Retrieval System	**(6 Hrs.)**
Automated material handling and storage: Functions, types, analysis of material handling equipments design on conveyors and AGV systems. Storage system performance- AS/RS- carousel storage system- WIP storage system interfacing handling, storage with manufacturing.	
Unit IV: Coordinate Measuring Machines	**(6 Hrs.)**
Introduction, Types, Construction and General Functions of CMM, Operational Cycle Description, CMM Applications, Importance to Flexible Cells and Systems.	
Unit IV: FMS application considerations	**(6 Hrs.)**
FMS Planning and Implementation Issues, Planning and Design Issues, Operations Management Issues.	
Unit VI: Modeling and Analysis of FMS	**(6 Hrs.)**
Analytical, heuristic, queuing, simulation and pertinent modeling techniques- scope, applicability and limitations.	
Total Lecture	**36 Hours**

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Textbooks:	
1.	Flexible Manufacturing System- HK Shivanand
2.	Groover M.P- Automation, Production Systems and CIM.
3.	Ranky P.G- The Design and Operation of FMS.

Reference Books:	
1.	Parrish D.J.- Flexible Manufacturing
2.	Jha N.K "Handbook of Flexible Manufacturing Systems", Academic Press Inc., 2006.
3.	Kalpakjin, "Manufacturing Engineering and Technology ", Addison Wesley Publishing Co., 1995.

MOOCs Links and additional reading, learning, video material	
1.	Automation in Manufacturing (https://onlinecourses.nptel.ac.in/noc24_me139/preview)
2.	CAD/CAM Computer Aided Design / Computer Aided Manufacturing (https://onlinecourses.swayam2.ac.in/nou24_me10/preview)
3.	Fundamentals of Manufacturing Processes (https://onlinecourses.nptel.ac.in/noc24_me123/preview)

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Program:	M. Tech. Mechanical (CIM)			Semester:			II
Course:	Industrial Robotics			Code:			MTMEPC06ME2T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	-	3	3	20	20	60	100

Methods of Teacher Assessment (TA): Attendance/classroom presentations/assignments/group discussion

Course Objectives:

- To understand the need and scope for robotics and to understand the principles of robot kinematics
- To design the drive systems and its control
- To understand the principles of sensors and vision systems
- To envision the industrial applications of robots and its safety

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Explain the basics of robotic systems.	L3
2	Design simple grippers for robotic applications	L5
3	Understand the basics of various drives and sensors to effectively design a robot	L2
4	Plan and design robot cell with safety considerations	L5
5	Apply the concept of robot arm kinematics	L4
6	Illustrate robot application and programming	L2

Unit I: Introduction to robots **(5 Hrs.)**

Definition need and scope of Industrial robots, Robot anatomy, Coordinate systems, Work envelope, Geometrical configurations and joint notations, Specifications, Actuators and drives.

Unit II: Robots end-effectors **(6 Hrs.)**

Classification of end-effectors, mechanical grippers, hooking or Lifting grippers, grippers for molten metal , plastics, vacuum cups, magnetic grippers Electrostatic grippers, multiple grippers, internal & external grippers, drive systems for gripers, active & passive grippers. Design consideration in gripper, gripper analysis.

Unit III: Robot drives & Sensors **(6 Hrs.)**

Pneumatic power drives, hydraulic systems, electric drives, Contact type sensors- wrist force sensor, binary & analog touch sensor, Artificial skins, force, torque, encoders, position, velocity sensors, Non contact type sensors;- vision sensor, proximity, range sensors, safety measures in robot.

Unit IV: Robot cell design and control **(6 Hrs.)**

Robot cell layouts – Multiple Robots and machine interference , work cell control, safety monitoring, interlocks, work cell controller, Robot cycle time analysis.

Unit V: Manipulator Kinematics **(7 Hrs.)**

Forward & reverse kinematics, forward and reverse transformation of two DOF & three DOF 2-D manipulator, homogeneous transformations, derivation and problems. Denavit-Hartenberg (DH) notations and parameters, Robot dynamics.

Unit VI: Robot Applications and Programming **(6 Hrs.)**

Applications of robot in material handling, processing, assembly, and inspection. Principals of robot application and application planning, justification of robots.
Robot Programming: Teach pendant programming, Lead through programming, Robot programming languages.

Total Lecture **36 Hours**

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Textbooks:	
1.	Deb, S.R." Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 1994.
2.	Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., "Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int., 1986.
3.	A. Ghosal.Robotics: Fundamental Concepts and Analysis, OxfordUniversity Press, 2006.
4.	S. K. Saha. Introduction to Robotics, McGraw Hill Education India, 2014.
5.	Koren,Y., "Robotics for Engineers", McGraw-Hill, 1987

Reference Books:	
1.	K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
2.	R. J. Schilling. Fundamentals of Robotics Analysis and Control, Pearson Education India, 2015.

MOOCs Links and additional reading, learning, video material	
1.	Industrial Robotics : Theories for Implementation (https://onlinecourses.nptel.ac.in/noc24_me117/preview)
2.	Mechanics and Control of Robotic Manipulators (https://onlinecourses.nptel.ac.in/noc24_me92/preview)
3.	Robotics (https://onlinecourses.nptel.ac.in/noc24_me88/preview)

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Program:	M. Tech. Mechanical (CIM)			Semester:			II
Course:	Lean Manufacturing			Code:			MTMEPC07ME2T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	-	3 Hours	3	20	20	60	100

Methods of Teacher Assessment (TA): Attendance/classroom presentations/assignments/group discussion

Course Objectives:

- To make the students aware on the importance, concept of lean manufacturing.
- To learn about lean tool like 5S and TPM.
- To study JIT and Kanban for improving productivity.
- To plan Jidoka and PokeYoke.
- To understand the need of six sigma for solving quality related issues.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Interpret the need of lean manufacturing.	L2
2	Develop total productive maintenance for industry.	L5
3	Summarize the need of JIT and Kanban.	L2
4	Develop Jidoka and Kanban.	L5
5	Solve the issues of quality by implementing six sigma.	L3
6	Evaluate the role of lean manufacturing through case studies.	L5

Unit I: Introduction to Lean Manufacturing	**6 (Hrs.)**
The mass production system, Origin of lean production system , Necessity – Lean revolution in Toyota , Systems and systems thinking , Basic image of lean production ,Customer focus , Muda (waste).	
Unit II: Stability of Lean System	**6 (Hrs.)**
Standards in the lean system, 5S system, Total Productive Maintenance, standardized work, Elements of standardized work, Charts to define standardized work, Man power reduction, and Overall efficiency - standardized work and Kaizen, Common layouts.	
Unit III:JUST IN TIME	**6 (Hrs.)**
Principles of JIT, JIT system, Kanban, Kanban rules, Expanded role of conveyance, Production leveling, Pull systems, Value stream mapping.	
Unit IV: JIDOKA (Automation With A Human Touch)	**6 (Hrs.)**
Jidoka concept, Poka-Yoke (mistake proofing) systems, Inspection systems and zone control, Types and use of Poka-Yoke systems, Implementation of Jidoka.	
Unit V: SIX SIGMA	**6 (Hrs.)**
Six Sigma – Definition, statistical considerations, variability reduction, design of experiments , Six Sigma implementation	
Unit VI: Case Studies	**6 (Hrs.)**
Various case studies of implementation of lean manufacturing at industries.	
Total Lecture	**36 Hours**

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Textbooks:	
1.	Dennis P.," Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System", (Second edition), Productivity Press, New York, 2007.
2.	Liker, J., "The Toyota Way: Fourteen Management Principles from the World's Greatest Manufacturer", McGraw Hill, 2004.
3.	Michael, L.G., "Lean Six SIGMA: Combining Six SIGMA Quality with Lean Production Speed",McGraw Hill, 2002.

Reference Books:	
1.	Ohno, T.," Toyota Production System: Beyond Large-Scale Production", Taylor & Francis, Inc., 1988.
2.	Rother, M., and Shook, J.,' Learning to See: Value Stream Mapping to Add Value and Eliminate MUDA", Lean Enterprise Institute, 1999.

MOOCs Links and additional reading, learning, video material	
1.	https://onlinecourses.nptel.ac.in/noc20_mg19/preview
2.	https://www.udemy.com/course/lean-management-certification-course

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Program:	M. Tech. Mechanical (CIM)			Semester:		II
Course:	Industrial Robotics Lab			Code:		MTMEPC08ME2P
Teaching Scheme				Evaluation Scheme		
Practical	Tutorial	Hours	Credit	INT	EXT	Total
2	-	2	1	25	25	50

Course Objectives: The course intends to provide the basics of robotics from robot configuration to robot kinematics and robot programming and operation.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Know about fundamental knowledge about the robot	L2
2	Know about robot motion analysis.	L2
3	Operate the robot	L4
4	Use programming languages for simple pick and place applications.	L4
5	Use simulation softwares for robotic applications.	L4

General Guidelines: All practicals are compulsory.

Expt. No.	List of Experiments
1	Study of Denavit And Hartenberg (DH) Parameters of Robot
2	Study of Robot Kinematics (positioning and orientation of robot arm)
3	Study And Performance On Articulated Arm Robot(Aristo- 6xt)
4	Programming of robot for Industrial application using offline programming languages.
5	Study of Robot Simulation Software (RoboAnalyzer)

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Program:	M. Tech. Mechanical (CIM)			Semester:			II
Course:	Rapid Prototyping & Tooling			Code:			MTMEPE10ME2T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	0	3	3	20	20	60	100

Methods of Teacher Assessment (TA): Assignments/ Viva/ Group Discussions/ Presentations

Course Objectives:

- To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology
- Gain insights on the need, advantages and limitations of additive manufacturing (AM) versus traditional manufacturing
- Find out the various applications of AM, Deployment levels, Innovative and optimized product design
- To explore the potential of additive manufacturing in different industrial sectors.
- To apply 3D printing technology for additive manufacturing.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Understand and use techniques for processing of CAD models for rapid prototyping.	L2
2	Understand and apply fundamentals of rapid prototyping techniques.	L2
3	Use appropriate tooling for rapid prototyping process.	L2
4	Use rapid prototyping techniques for reverse engineering.	L3
5	Apply rapid prototyping to various engineering applications.	L4
6	Understand and use rapid tooling in various engineering applications.	L2

Unit I: Introduction to Rapid Prototyping **(5 Hrs.)**

Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP.

Unit II: CAD Modeling and Data Processing for RP **(6 Hrs.)**

CAD model preparation, Data Requirements, Data formats (STL, SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP), Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

Unit III: RP Systems **(8 Hrs.)**

Photopolymerizatin: Stereo lithography (SL), SL resin curing process, SL scan patterns, Microstereolithography, Applications of Photo polymerization Processes.
Powder Bed Fusion: Selective laser Sintering (SLS), Powder fusion mechanism and powder handling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Applications of Powder Bed Fusion Processes.
Extrusion-Based RP Systems: Fused Deposition Modeling (FDM), Principles, Plotting and path control, Applications of Extrusion-Based Processes.
3D Printing: 3D printing (3DP), Research achievements in printing deposition, Technical challenges in printing, Printing process modeling, Applications of Printing Processes.
Sheet Lamination: Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.
Beam Deposition: Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Processing-structure-properties, relationships, Benefits and drawbacks.

Unit IV: Reverse Engineering **(6 Hrs.)**

Basic concept, Digitization techniques, Model Reconstruction, Data Processing for Rapid Prototyping, Reverse Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development.

Unit IV: RP Applications **(5 Hrs.)**

Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP.

Unit VI: Rapid Tooling **(6 Hrs.)**

Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods.

Total Lecture **36 Hours**

Textbooks:	
1.	Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific.
2.	Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.

Reference Books:	
1.	Gibson D W Rosen, Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer.
2.	Noorani R, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons.
3.	Hilton P, Jacobs P F, Rapid Tooling: Technologies and Industrial Applications, CRC press.
4.	Liou W L, Liou F W, Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press.
5.	Kamrani A K, Nasr E A, Rapid Prototyping: Theory and practice, Springer
6.	Kalpakjin, "Manufacturing Engineering and Technology ", Addison Wesley Publishing Co., 1995.

MOOCs Links and additional reading, learning, video material	
1.	Rapid Manufacturing (https://onlinecourses.nptel.ac.in/noc24_me115/preview)
2.	Fundamentals of Additive Manufacturing Technologies (https://onlinecourses.nptel.ac.in/noc24_me138/preview)
3.	Metal Additive Manufacturing (https://onlinecourses.nptel.ac.in/noc24_me130/preview)
4.	3D Printing and Design (https://onlinecourses.swayam2.ac.in/ntr24_ed41/preview)

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Program:	M. Tech. Mechanical (CIM)			Semester:		II
Course:	Rapid Prototyping & Tooling Lab			Code:		MTMEPE11ME2P
Teaching Scheme				Evaluation Scheme		
Practical	Tutorial	Hours	Credit	INT	EXT	Total
2	-	2	1	25	25	50

Course Objectives:

- To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology
- Find out the various applications of AM, Deployment levels, Innovative and optimized product design
- To apply 3D printing technology for additive manufacturing.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Distinguish RP and other related technology	L2
2	Understand and use techniques for processing of CAD models for rapid prototyping.	L2
3	Apply fundamentals of rapid prototyping techniques.	L4
4	Use appropriate tooling for rapid prototyping process.	L4
5	Create component with RP applications	L5

General Guidelines: All practicals are compulsory.

Expt. No.	List of Experiments
1	Generating a 3D model on any CAD software.
2	Generating STL files from the CAD Models & Working on STL files.
3	Review of CAD Modeling Techniques and Introduction to RP.
4	Setting up a 3D printing machine and detailed study of its various parts and accessories.
5	Fabricating a physical component on a RP machine

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Program:	M. Tech. Mechanical (CIM)			Semester:			II
Course:	Competitive Manufacturing			Code:			MTMEPE12ME2T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	-	3 Hours	3	20	20	60	100

Methods of Teacher Assessment (TA): Assignments/ Viva/ Group Discussions/ Presentations

Course Objectives:
1. To make the students aware about various issues in manufacturing sector.
2. To learn about historical perspective world class excellent organizations.
3. To understand competitive and manufacturing strategies.
4. To study bottlenecks and benchmark in manufacturing industry.
5. To plan human resource management in manufacturing industry.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Illustrate the environmental issues in manufacturing sector.	L2
2	Interpret recent trends in manufacturing.	L2
3	Outline competitive and manufacturing strategy.	L4
4	Demonstrate the relevance and basics of World Class Manufacturing.	L2
5	Show the importance of Human resource Management in World Class Manufacturing.	L2
6	Compare the existing industries with WCM industries.	L2

Unit I: Introduction — **6 (Hrs.)**

Introduction to the environmental issues pertaining to the manufacturing sector, pressure to reduce costs , processes that minimize negative environmental impacts, environmental legislation and energy costs , acceptable practice in society, adoption of low carbon technologies, need to reduce the carbon footprint of manufacturing operations

Unit II: Historical Perspective World class Excellent organizations — **6 (Hrs.)**

Historical Perspective World class Excellent organizations – Models for manufacturing excellence: Schonberger, Halls, Gunn and Maskell models, Business Excellence.

Unit III: Concepts of Competitive Strategy and Manufacturing Strategies — **6 (Hrs.)**

Concepts of Competitive Strategy and Manufacturing Strategies and development of a strategic improvement programme ,Manufacturing strategy in business , success Strategy formation and formulation , Structured strategy formulation – Sustainable manufacturing system design options , Approaches to strategy formulation ,Realization of new strategies/system designs

Unit IV: Benchmark — **6 (Hrs.)**

Benchmark, Bottlenecks and Best Practices, Concepts of benchmarking, Bottleneck and best practices, Best performers , Gaining competitive edge through world class manufacturing , Value added manufacturing ,Value Stream mapping , Eliminating waste ,Toyota Production System –Example.

Unit V: Human Resource Management in WCM — **6 (Hrs.)**

Adding value to the organization, Organizational learning, techniques of removing Root cause of problems, People as problem solvers, New organizational structures. Associates, Facilitators, Teamsmanship, Motivation and reward in the age of continuous improvement.

Unit VI: Typical Characteristics of WCM — **6 (Hrs.)**

Typical Characteristics of WCM Companies Performance indicators like POP, TOPP and AMBITE systems– what is world class Performance –Six Sigma philosophy. Indian Scenario on world class manufacturing –Task Ahead. Green Manufacturing, Clean manufacturing, Agile manufacturing.

Total Lecture — **36 Hours**

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Textbooks:	
1.	Seliger, G, "Sustainable Manufacturing: Shaping Global Value Creation", Springer ,2012
2.	World Class Manufacturing Strategic Perspective Sahay B.S., Saxena KBC. and Ashish Kumar Mac Milan Publications New Delhi
3.	World Class Manufacturing- The Lesson of Simplicity Schonberger R. J Free Press 1986

Reference Books:	
1.	The Toyota Way – 14 Management Principles Jeffrey K.Liker Mc-Graw Hill 2003
2.	Production and Operational Management Adam and Ebert Prentice Hall learning Pvt. Ltd. 5th Edition
3.	Operations Management for Competitive Advantage Chase Richard B., Jacob Robert McGraw Hill Publications 11th Edition 2005

MOOCs Links and additional reading, learning, video material	
1.	https://www.udemy.com/course/world-class-manufacturing-lean-thinking/
2.	https://www.shiksha.com/online-courses/certified-world-class-manufacturing-wcm-practices-manager-course-v259

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Program:	M. Tech. Mechanical (CIM)			Semester:	II	
Course:	Competitive Manufacturing Lab			Code:	MTMEPE13ME2P	
Teaching Scheme				Evaluation Scheme		
Practical	Tutorial	Hours	Credit	INT	EXT	Total
2	-	2	1	25	25	50

Course Objectives:

- To make the students aware about various issues in manufacturing sector.
- Understand competitive and manufacturing strategies.
- Understand the futuristic need of agile , green and value added manufacturing.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Identification of key elements of manufacturing sector.	L2
2	Understanding the concept of agile and green manufacturing.	L2
3	Interpret the need of TPS and Six Sigma for Competitive manufacturing.	L3
4	Illustrate value added manufacturing for world class manufacturing.	L3

General Guidelines: At least 5 practicals to be conducted from the given list.

Expt. No.	List of Experiments
1	Study of environmental issues pertaining to the manufacturing sector.
2	Study of adoption of low carbon technologies in manufacturing sector.
3	Study of sustainable manufacturing system.
4	Study of Toyota Production System – Case Study.
5	Study of Green Manufacturing
6	Study of Six Sigma – Case Study.
7	Study of Value added manufacturing.
8	Study of Agile manufacturing.

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Program:	M. Tech. Mechanical (CIM)			Semester:			II
Course:	Manufacturing System Simulation			Code:			MTMEPE14ME2T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credits	TA	MSE	ESE	Total
3	0	3	3	20	20	60	100

Methods of Teacher Assessment (TA): Assignments/ Viva/ Group Discussions/ Presentations

Course Objectives:

- To introduce computer simulation technologies and techniques
- To introduce concepts of modeling layers of simulation system.
- To build tools to view and control simulations and their results

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Understand terminologies related to system simulation.	L2
2	Demonstrate techniques generation of random number.	L2
3	Demonstrate techniques generation of random variates.	L2
4	Analyses simulation input date.	L4
5	Interpret simulation output.	L2
6	Develop simulation of case studies in manufacturing	L3

Unit I: Introduction	**(6 Hrs.)**
Systems and modeling – statistical models in simulation -discrete and continuous system -Monte Carlo Simulation. Simulation of Single Server Queuing System. Simulation of manufacturing shop Simulation of Inventory System	
Unit II: Random Numbers	**(6Hrs.)**
Random number generation -Properties of Random Numbers –Generation of Pseudo Random Numbers – Techniques –Tests for Random Numbers	
Unit III: Random Variates	**(6 Hrs.)**
Random variate generation-Inverse Transform Technique –Direct Transform Techniques Convolution Method Acceptance Rejection Technique– Routines for Random Variate Generation, Testing -Analysis of simulation data.	
Unit IV: Analysis Of Simulation Input Data	**(7 Hrs.)**
Input modeling -Fitness tests – verification and validation of simulation models.	
Unit V: Analysis Of Simulation Output	**(7 Hrs.)**
Output analysis for a single model, Comparison and evaluation of alternate system design, Optimization using simulation.	
Unit VI: Case Studies	**(6 Hrs.)**
Applications of simulation in manufacturing -Case studies in manufacturing and material handling system.	
Total Lecture	**Hours 38**

Textbooks:

1. Geoffrey Gordon, "System Simulation", 2nd Edition, Prentice Hall, India, 2002.
2. Jerry Banks & John S.Carson, Barry L Nelson, "Discrete event system simulation", Prentice Hall
3. Law A.M, "Simulation Modelling and Analysis", Tata Mc Graw Hill

Reference Books:

1. NarsinghDeo, "System Simulation with Digital Computer", Prentice Hall
2. Pidd, M, "Computer Simulation in Management Science", John Wiley & Sons, Inc.
3. A Course in Simulation /Ross, S.M., McMillan, NY, 1990.

MOOCs Links and additional reading, learning, video material

1. https://archive.nptel.ac.in/courses/112/107/112107220/
2. https://ndl.iitkgp.ac.in/

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Program:	M. Tech. Mechanical (CIM)			Semester:		II
Course:	Manufacturing System Simulation Lab			Code:		MTMEPE15ME2P
Teaching Scheme				Evaluation Scheme		
Practical	Tutorial	Hours	Credits	INT	EXT	Total
2	0	2	1	30	20	50

Course Objectives:

- Understand the concept of Simulation
- Understand the concept of random number & random variates.
- Understand the concept of input & output date analysis.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Understand terminologies related to system simulation.	L2
2	Demonstrate techniques generation of random number.	L2
3	Demonstrate techniques generation of random variates.	L2
4	Analyses simulation input date.	L4
5	Interpret simulation output.	L2
6	Develop simulation of case studies in manufacturing	L3

General Guidelines: At least 5 practicals are to be conducted from the given list.

Pract. No.	List of Practical
1	Study of Monte Carlo Simulation for Single Server Queuing System.
2	Generation of Pseudo Random Numbers.
3	Generation of Pseudo Random variates.
4	Analysis of simulation input data.
5	Analysis of simulation output date.
6	Case studies in manufacturing or material handling system.

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Program:	M. Tech. Mechanical (CIM)			Semester:			II
Course:	Product Life Cycle Management			Code:			MTMEPE16ME2T
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Hours	Credit	TA	MSE	ESE	Total
3	-	3 Hours	3	20	20	60	100

Methods of Teacher Assessment (TA): Assignments/ Viva/ Group Discussions/ Presentations

Course Objectives:

- To make the students aware on the importance, concept of Product Life Cycle Management.
- To learn about various product development approaches.
- To study various methods of product modeling.
- To study the concept of product data management.
- To understand integration of PLM with other applications.
- 6. To study various PLM software.

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

CO	Course Outcomes	BT Level (L1 to L6)
1	Explain basic concepts of product life cycle management.	L2
2	Demonstrate product development approaches.	L2
3	Explain elements of product modeling.	L2
4	Discuss in detail the concept of product data management.	L6
5	Discuss about integration of PLM with other applications.	L6
6	Illustrate various PLM software.	L2

Unit I: Introduction to PLM	**6 (Hrs.)**
Background, Overview, Need, Benefits, Concept of Product Life Cycle. Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement. Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change Management for PLM	
Unit II: Product Development	**6 (Hrs.)**
Product Development Approaches: Bottom-up design, Top-down design, Front-loading design workflow, Design in context, Modular design. Concurrent engineering, partnership with supplier, collaborative and Internet based design, work structuring and team deployment, Product and process systemization, problem, identification and solving methodologies, improving product development solutions	
Unit III:Product Modeling	**6 (Hrs.)**
Product Modeling - Definition of concepts, Fundamental issues, Role of Process chains and product models ,Types of product models , model standardization efforts-types of process chains , Industrial demands. Foundation technologies and standards (e.g. visualization, collaboration and enterprise application integration).	
Unit IV: Product Data Management	**6 (Hrs.)**
Product Data Management (PDM) –Benefits and Terminology, PDM functions, definition and architectures of PDM systems, product data interchange, portal integration, PDM acquisition and implementation. Information authoring tools (e.g., MCAD, ECAD, and technical publishing)	
Unit V: Integration of PLM With Other Applications	**6 (Hrs.)**
Different ways to integrate PLM systems, Transfer file, Database integration, System roles, ERP, Optimization of ERP for PLM and CAD. Different ways to integrate PLM systems, Transfer file, Database integration, System roles, ERP, Optimization of ERP for PLM and CAD. PLM	
Unit VI:PLM Softwares	**6 (Hrs.)**
Basic features and modules of ENOVIA and Windchill.	
Total Lecture	**36 Hours**

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Textbooks:	
1.	Grieves, Michael. "Product Lifecycle Management", McGraw-Hill, 2006. ISBN 0071452303
2.	Saaksvuori Antti / Immonen Anselmie, "Product Life Cycle Management", Springer,Dreamtech,3-540- 25731-4.
3.	Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN 1852338105.

Reference Books:	
1.	Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006.

MOOCs Links and additional reading, learning,video material	
1.	https://www.cimdata.com/en/education/plm-basics-e-learning-course
2.	https://www.cimdata.com/en/education/plm-certificate-program

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