KSR College of Engineering

NAAC ACCREDITED A++ | NBA ACCREDITED PROGRAMMES

AN AUTONOMOUS INSTITUTION

M.E. - CAD/CAM

Curriculum & Syllabus for

REGULATIONS 2024

(ACADEMIC YEAR 2024-25 ONWARDS)

K.S.R. COLLEGE OF ENGINEERING : TIRUCHENGODE - 637 215
(Autonomous)
CAD/CAM ENGINEERING
(REGULATIONS 2024)

Vision of the Institution

IV	We envision to achieve status as an excellent educational institution in the global knowledge hub, making self-learners, experts, ethical and responsible engineers, technologists, scientists, managers, administrators and entrepreneurs who will significantly contribute to research and environment friendly sustainable growth of the nation and the world.

Mission of the Institution

IM 1	To inculcate in the students self-learning abilities that enable them to become competitive and considerate engineers, technologists, scientists, managers, administrators and entrepreneurs by diligently imparting the best of education, nurturing environmental and social needs.
IM 2	To foster and maintain mutually beneficial partnership with global industries and Institutions through knowledge sharing, collaborative research and innovation.

Vision of the Department / Programme: (Mechanical Engineering)

DV	To be a centre of excellence in the field of Mechanical Engineering for providing its students and faculty with opportunities for excel in education and targeted research themes in emerging areas.

Mission of the Department / Programme: (Mechanical Engineering)

DM 1	To excel in academic and research activities that meet the industrial and social needs.
DM 2	To develop competent, innovative and ethical mechanical Engineers.

Programme Educational Objectives (PEOs) :(Mechanical Engineering)

The graduates of the programme will be able to	
PEO 1	To Impart knowledge to students in recent advances in the Computer Aided Manufacturing to educate them to prosper in Manufacturing engineering and research related professions.
PEO 2	To enhance the scientific and engineering fundamentals the provide students with a solid foundation in required to solve analytical problems
PEO 3	To coach students with good design and engineering skills so as to comprehend, analyze, design, and produce novel materials, products and solutions for the contemporary manufacturing issues.
PEO 4	To inculcate students with professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate Computer Integrated Manufacturing engineering issues to broader engineering and social context.

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CAD/CAM ENGINEERING

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PROGRAMME OUTCOMES (POs) AND PROGRAMME SPECIFIC OUTCOMES (PSOs)

Programme Outcomes (POs)	
PO1	An ability to independently carry out research/investigation and development work to solve practical problems
PO2	An ability to write and present a substantial technical report/document
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO4	Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze engineering problems.
PO5	Graduates will demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks in the design and manufacturing applications
PO6	Responsibility of understanding ethically and professionally and develop confidence for self-education and ability for life-long learning
Programme Specific Outcomes (PSOs)	
PSO1	Design, analyse, formulate and solve engineering problems using computer software, tools and techniques.
PSO2	Adopt and demonstrate multidisciplinary approach to solve design, manufacturing and allied problems.

KSR College of Engineering	**K. S. R COLLEGE OF ENGINEERING** **An Autonomous Institution** **Approved by AICTE and Affiliated to Anna University, Chennai** **Accredited by NBA,NAAC ('A++' Grade)**	**Curriculum** **PG** **R - 2024**
Department	**Department of Mechanical Engineering**	
Programme	**M.E. CAD/CAM**	

SEMESTER I

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
Induction Programme			-	-	-	-	-	-	-	-	-
THEORY COURSES											
1	CC24T11	Computer Applications in Design	PCC	3	0	0	3	**3**	40	60	100
2	CC24T12	Computer Aided Manufacturing	PCC	3	0	0	3	**3**	40	60	100
3	CC24T13	Advanced Manufacturing Processes	PCC	3	0	0	3	**3**	40	60	100
4	RM24T19	Research Methodology and IPR	RMC	3	0	0	3	**3**	40	60	100
5		Professional Elective–I	PEC	3	0	0	3	**3**	40	60	100
6		Professional Elective–II	PEC	3	0	0	3	**3**	40	60	100
LABORATORY COURSES											
7	CC24P11	Computer Aided Design Laboratory	PCC	0	0	4	4	**2**	60	40	100
8	CC24P12	Computer Aided Manufacturing Laboratory	PCC	0	0	4	4	**2**	60	40	100
			TOTAL	**18**	**0**	**8**	**26**	**22**	**800**		

SEMESTER II

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
THEORY COURSES											
1	CC24T21	Product Life cycle Management	PCC	3	0	0	3	**3**	40	60	100
2	CC24T22	Finite Element Methods in Mechanical Design	PCC	3	0	0	3	**3**	40	60	100
3	CC24T23	Solid Freeform Manufacturing	PCC	3	0	0	3	**3**	40	60	100
4	CC24T24	Industry 4.0	PCC	3	0	0	3	**3**	40	60	100
5		Professional Elective-III	PEC	3	0	0	3	**3**	40	60	100
6		Professional Elective-IV	PEC	3	0	0	3	**3**	40	60	100
LABORATORY COURSES											
7	CC24P21	Rapid Prototyping Laboratory	PCC	0	0	4	4	**2**	60	40	100
8	CC24P22	Simulation and Analysis Laboratory	PCC	0	0	4	4	**2**	60	40	100
			TOTAL	**18**	**0**	**8**	**26**	**22**	**800**		

	K. S. R COLLEGE OF ENGINEERING An Autonomous Institution Approved by AICTE and Affiliated to Anna University, Chennai Accredited by NBA,NAAC ('A++' Grade)	Curriculum PG R - 2024
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Programme	**M.E. CAD/CAM**	

SEMESTER III

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
THEORY COURSES											
1	CC24T31	Design for Sustainability	PCC	3	0	0	3	**3**	40	60	100
2		Professional Elective-V	PEC	3	0	0	3	**3**	40	60	100
3		Open Elective	OEC	3	0	0	3	**3**	40	60	100
EMPLOYABILITY ENHANCEMENT COURSES											
4	CC24P31	Technical Presentation	EEC	0	0	2	2	**1**	60	40	100
5	CC24P32	Project Work I	EEC	0	0	12	12	**6**	60	40	100
AUDIT COURSES											
6		Audit Course	AC	2	0	0	2	**0**	100	-	100
			TOTAL	**11**	**0**	**14**	**25**	**16**	**600**		

SEMESTER IV

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
EMPLOYABILITY ENHANCEMENT COURSES											
1	CC24P41	Project Work II	EEC	0	0	24	24	**12**	60	40	100
			TOTAL	**0**	**0**	**24**	**24**	**12**	**100**		

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Programme	**M.E. CAD/CAM**	

PROFESSIONAL CORE COURSES (PCC)

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
1.	CC24T11	Computer Applications in Design	PCC	3	0	0	3	**3**	40	60	100
2.	CC24T12	Computer Aided Manufacturing	PCC	3	0	0	3	**3**	40	60	100
3.	CC24T13	Advanced Manufacturing Processes	PCC	3	0	0	3	**3**	40	60	100
4.	CC24P11	Computer Aided Design Laboratory	PCC	0	0	4	4	**2**	60	40	100
5.	CC24P12	Computer Aided Manufacturing Laboratory	PCC	0	0	4	4	2	60	40	100
6.	CC24T21	Product Lifecycle Management	PCC	3	0	0	3	**3**	40	60	100
7.	CC24T22	Finite Element Methods in Mechanical Design	PCC	3	0	0	3	**3**	40	60	100
8.	CC24T23	Solid Freeform Manufacturing	PCC	3	0	0	3	**3**	40	60	100
9.	CC24T24	Industry 4.0	PCC	3	0	0	3	**3**	40	60	100
10.	CC24P21	Rapid Prototyping Laboratory	PCC	0	0	4	4	**2**	60	40	100
11.	CC24P22	Simulation and Analysis Laboratory	PCC	0	0	4	4	**2**	60	40	100
12.	CC24T31	Design for Sustainability	PCC	3	0	0	3	**3**	40	60	100
			TOTAL	**24**	**0**	**16**	**40**	**32**			

RESEARCH METHODOLOGY AND IPR COURSE (RMC)

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
1	RM24T19	Research Methodology and IPR	RMC	3	0	0	3	**3**	40	60	100
			TOTAL	**3**	**0**	**0**	**3**	**3**			

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
1	CC24P31	Technical Presentation	EEC	0	0	2	2	**1**	60	40	100
2	CC24P32	Project Work I	EEC	0	0	12	12	**6**	60	40	100
3	CC24P41	Project Work II	EEC	0	0	24	24	**12**	60	40	100
			TOTAL	**0**	**0**	**38**	**38**	**19**			

PROFESSIONAL ELECTIVE COURSES (PEC)											
PROFESSIONAL ELECTIVE - I and II (SEMESTER- I)											
S. No.	**Course Code**	**Course Title**	**Category**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot**		**CA**	**ES**	**Tot**
1	CC24E01	Integrated Product Development	PEC	3	0	0	3	**3**	40	60	100
2	CC24E02	Composite Materials and Mechanics	PEC	3	0	0	3	**3**	40	60	100
3	CC24E03	Computer Control in Process Planning	PEC	3	0	0	3	**3**	40	60	100
4	CC24E04	Advanced Finite Element Analysis	PEC	3	0	0	3	**3**	40	60	100
5	CC24E05	Optimization Techniques in Design	PEC	3	0	0	3	**3**	40	60	100
6	CC24E06	Advanced Machine tool Design	PEC	3	0	0	3	**3**	40	60	100
7	CC24E07	Reverse Engineering	PEC	3	0	0	3	**3**	40	60	100
PROFESSIONAL ELECTIVE –III and IV (SEMESTER-II)											
S. No.	**Course Code**	**Course Title**	**Category**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot**		**CA**	**ES**	**Tot**
1	CC24E08	Industrial Safety Management	PEC	3	0	0	3	**3**	40	60	100
2	CC24E09	Mechanical Measurements and Analysis	PEC	3	0	0	3	**3**	40	60	100
3	CC24E10	Reliability in Engineering Systems	PEC	3	0	0	3	**3**	40	60	100
4	CC24E11	Lean Manufacturing	PEC	3	0	0	3	**3**	40	60	100
5	CC24E12	Performance Modeling and Analysis of Manufacturing Systems	PEC	3	0	0	3	3	40	60	100
6	CC24E13	Creativity and Innovation	PEC	3	0	0	3	3	40	60	100
7	CC24E14	Industrial Robotics and Expert systems	PEC	3	0	0	3	3	40	60	100
8	CC24E15	Design for Cellular Manufacturing Systems	PEC	3	0	0	3	3	40	60	100
9	CC24E16	Manufacturing Technology For Electronic Devices	PEC	3	0	0	3	3	40	60	100
10	CC24E17	Smart Manufacturing	PEC	3	0	0	3	3	40	60	100
PROFESSIONAL ELECTIVE –V (SEMESTER-III)											
S. No.	**Course Code**	**Course Title**	**Category**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot**		**CA**	**ES**	**Tot**
1	CC24E18	Quality Concepts in Design	PEC	3	0	0	3	3	40	60	100
2	CC24E19	Non–Destructive Testing	PEC	3	0	0	3	3	40	60	100
3	CC24E20	Design of Hybrid and Electric Vehicles	PEC	3	0	0	3	3	40	60	100
4	CC24E21	Material Handling Systems and Design	PEC	3	0	0	3	3	40	60	100
5	CC24E22	Designing with Advanced Materials	PEC	3	0	0	3	3	40	60	100
6	CC24E23	Advances in Manufacturing Processes	PEC	3	0	0	3	3	40	60	100
AUDIT COURSES (AC)											
S. No.	**Course Code**	**Course Title**	**Category**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot**		**CA**	**ES**	**Tot**
1	AX24A01	Disaster Management	AC	2	0	0	2	0	100	-	100
2	AX24A02	Value Education	AC	2	0	0	2	0	100	-	100
3	AX24A03	Constitution of India	AC	2	0	0	2	0	100	-	100
4	AX24A04	Indian Knowledge System	AC	2	0	0	2	0	100	-	100

OPEN ELECTIVE COURSES											
S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
COMPUTER SCIENCE AND ENGINEERING											
1	CS24O01	Machine learning and Deep Learning	OEC	3	0	0	3	**3**	40	60	100
2	CS24O02	Blockchain and Crypto Currency	OEC	3	0	0	3	**3**	40	60	100
3	CS24O03	Multimedia Technologies	OEC	3	0	0	3	**3**	40	60	100
BIG DATA ANALYTICS											
4	BD24O01	Big Data Analytics	OEC	3	0	0	3	**3**	40	60	100
5	BD24O02	Internet of Things and Cloud	OEC	3	0	0	3	**3**	40	60	100
6	BD24O03	Big Data Visualization	OEC	3	0	0	3	**3**	40	60	100
POWER ELECTRONICS AND DRIVE											
7	PE24O01	Switching Concepts and Power	OEC	3	0	0	3	**3**	40	60	100
8	PE24O02	Smart Grid Technology	OEC	3	0	0	3	**3**	40	60	100
9	PE24O03	Renewable Energy Technology	OEC	3	0	0	3	**3**	40	60	100
10	PE24O04	Energy Management and Conservation	OEC	3	0	0	3	**3**	40	60	100
EMBEDDED SYSTEMS TECHNOLOGY											
11	ET24O01	Embedded Systems	OEC	3	0	0	3	**3**	40	60	100
12	ET24O02	Embedded Control	OEC	3	0	0	3	**3**	40	60	100
13	ET24O03	Embedded Automation	OEC	3	0	0	3	**3**	40	60	100
INFORMATION TECHNOLOGY											
14	IT24O01	IoT for Smart System	OEC	3	0	0	3	**3**	40	60	100
15	IT24O02	Machine Learning for Intelligent	OEC	3	0	0	3	**3**	40	60	100
16	IT24O03	DevOps and Microservices	OEC	3	0	0	3	**3**	40	60	100
17	IT24O04	Cyber security and Digital Awareness	OEC	3	0	0	3	**3**	40	60	100
CONSTRUCTION ENGINEERING AND MANAGEMENT											
18	CN24O01	Energy Efficient Building	OEC	3	0	0	3	**3**	40	60	100
19	CN24O02	Economics and Finance management	OEC	3	0	0	3	**3**	40	60	100
20	CN24O03	Stress management	OEC	3	0	0	3	**3**	40	60	100
STRUCTURAL ENGINEERING											
21	ST24O01	Principles of Sustainable	OEC	3	0	0	3	**3**	40	60	100
22	ST24O02	Failure Analysis of Structures	OEC	3	0	0	3	**3**	40	60	100
23	ST24O03	Smart materials and Smart Structures	OEC	3	0	0	3	**3**	40	60	100
COMMUNICATION SYSTEMS											
24	CU24O01	Principles of Multimedia	OEC	3	0	0	3	**3**	40	60	100
25	CU24O02	Software Defined Radio	OEC	3	0	0	3	**3**	40	60	100
26	CU24O03	MEMS & NEMS	OEC	3	0	0	3	**3**	40	60	100

27	CU24O04	Introduction to cognitive Radio Network	OEC	3	0	0	3	**3**	40	60	100
INDUSTRIAL SAFETY ENGINEERING											
28	IS24O01	Industrial Safety Engineering	OEC	3	0	0	3	**3**	40	60	100
29	IS24O02	Fire Engineering and Protection	OEC	3	0	0	3	**3**	40	60	100
30	IS24O03	Food and Bio-safety	OEC	3	0	0	3	**3**	40	60	100
OPEN ELECTIVE COURSES OFFERED BY CAD/CAM ENGINEERING											
1	CC24O01	Digital Manufacturing	OEC	3	0	0	3	**3**	40	60	100
2	CC24O02	Design for Manufacturing and Assembly	OEC	3	0	0	3	**3**	40	60	100
3	CC24O03	Smart Materials and Structures	OEC	3	0	0	3	**3**	40	60	100

Summary

Name of the Programme: M.E CAD/CAM

CATEGORY	Credits per Semester				TOTAL CREDITS	%
	I	II	III	IV		
PCC	13	16	03		32	44.44
RMC	03				03	04.17
PEC	06	06	03		15	20.83
OEC			03		03	04.17
EEC			07	12	19	26.39
AC			√			
Total	22	22	16	12	72	100

CC24T11	COMPUTER APPLICATIONS IN DESIGN	Category	L	T		C
		PCC	3	0	0	3

PREREQUISITE:
Students must understand basic design principles, mechanical components, and systems is often essential. Familiarity with computer-aided design (CAD) software like Solid Edge, AutoCAD, or SolidWorks is often required

OBJECTIVES:

The Course will enable learners to:

- To understand fundamental concepts of computer graphics and its tools in a generic framework.
- To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and soli
- To impart the parametric fundamentals to create and manipulate geometric models using NURBS and solids.
- To provide clear understanding of CAD systems for 3D modeling and viewing.
- To create strong skills of assembly modeling and prepare the student to be an effective user of a standards in CAD system.

UNIT - I	INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS	9

Overview of Graphics systems: Video Display Devices, Raster-Scan System, Random-Scan Systems, Graphics Monitors and Workstations, Input Devices, Hard-Copy Devices, Graphics Software. Ouput primitives: Line Drawing Algorithm - DDA, Bresenham's and Parallel Line Algorithm. Circle generating algorithm – Midpoint Circle Algorithm.
Geometric Transformations: Coordinate Transformations, Windowing and Clipping, 2D Geometric transformations-Translation, Scaling, Shearing, Rotation and Reflection, Composite transformation,3D transformations.

UNIT - II	CURVES AND SURFACES MODELLING	9

Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline-Bezier curve and B-Spline curve – curve manipulations.

Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermitebicubic surface- Bezier surface and B-Spline surface-surface manipulations.

UNIT - III	NURBS AND SOLID MODELING	9

NURBS- Basics- curves, lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations - constructive solid Geometry - comparison of representations - user interface for solid modeling

UNIT - IV	VISUAL REALISM	9

Hidden Line removal, Hidden Surface removal, – Hidden Solid Removal algorithms - Shading – Coloring.Animation - Conventional, Computer animation, Engineering animation - types and techniques.

UNIT - V	ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLE MANAGEMENT	9

Assembly modeling – Design for manufacture – Design for assembly – computer aided DFMA - inferences of positions and orientation - tolerances analysis –Center of Gravity and mass property calculations - mechanism simulation. Graphics and computing standards - Data Exchange standards.

Product development and management – new product development –models utilized in various phases of new product development – managing product life cycle

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Solve 2D and 3D transformations for the basic entities like line and circle.	Apply
CO2	Formulate the basic mathematics fundamental to CAD system.	Analysis
CO3	Use the different geometric modeling techniques like feature based modeling, surface modeling and solid modeling.	Understand
CO4	Apply geometric models through animation and transform them into real world systems	Apply
CO5	Simulate assembly of parts using Computer-Aided Design software	Analysis

TEXT BOOKS:

1. Boothroyd, G, "Assembly Automation and Product Design" Marcel Dekker, New York, 1997.
2. Chitale A.K and Gupta R.C "Product design and manufacturing "PHI learning private limited, 6th Edition, 2015.

REFERENCES:

1. David Rogers, James Alan Adams "Mathematical Elements for Computer Graphics"2nd Edition, Tata McGraw-Hill edition.2003
2. Donald D Hearn and M. Pauline Baker "Computer Graphics C Version", Prentice Hall, Inc.,2nd Edition, 1996.
3. Ibhim Zeid, "Mastering CAD/CAM", McGraw Hill, 2nd Edition, 2006
4. William M Newman and Robert F.Sproull "Principles of Interactive Computer Graphics", McGraw Hill Book Co. 1stEdition, 2001.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	1	-	-	-	-	-	-	2	3
CO2	3	3	2	2	1	1	-	-	-	-	-	-	2	3
CO3	3	3	2	2	1	1	-	-	-	-	-	-	2	3
CO4	3	2	2	2	1	1	-	-	-	-	-	-	2	3
CO5	3	2	2	2	1	1	-	-	-	-	-	-	2	3
Avg.	3	3	2	2	**1**	**1**	-	-	-	-	-	-	2	3

CC24T12	COMPUTER AIDED MANUFACTURING	Category	L	T		C
		PCC	3	0	0	3

PREREQUISITE:
Students must Know the basic manufacturing processes such as machining, casting, and forming is essential to understand how CAM systems apply to real-world manufacturing.

OBJECTIVES:

The Course will enable learners to:

- Provide an overview of how computers are being used in mechanical component design and familiarize in CNC Programming for turning operations.
- Summarize the process of reconstructing/ reformation of an already existing object.
- Prepare the students for computer aided tools that can be implemented in various industrial applications and to generate part programs using CAM packages for milling and turning machines
- Understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost & Layout.
- Introduce the concept of printing parts using additive manufacturing and to introduce Relational database management system in Material requirements planning

UNIT - I	COMPUTER AIDED MANUFACTURING	9

Manufacturing Processes – Removing, Forming, Deforming and joining – Integration equipments. Integrating CAD, NC and CAM – Machine tools – Point to point and continuous path machining, NC, CNC and DNC – NC Programming – Basics, Languages, G Code, M Code, APT – Tool path generation and verification – CAD/CAM NC Programming – Production Control – Cellular Manufacturing

UNIT - II	COMPUTER AIDED PROCESS PLANNING	9

Role of process planning in CAD/CAM Integration – Computer Aided Process Planning – Development, Benefits, Model and Architecture – CAPP Approaches – Variant, Generative and Hybrid – Process and Planning systems – CAM-I, D-CLASS and CMPP – Criteria in selecting a CAPP System.

UNIT - III	COMPUTER AIDED INSPECTION	9

Engineering Tolerances – Need for Tolerances – Conventional Tolerances – FITS and LIMITS – Tolerance Accumulation and Surface quality – Geometric Tolerances – Tolerances Practices in design, Drafting and manufacturing – Tolerance Analysis – Tolerance synthesis – Computer Aided Quality control – Contact Inspection Methods – Non Contact Inspection Methods - Non optical.

UNIT - IV	REVERSE ENGINEERING	9

Scope and tasks of Reverse Engineering – Domain Analysis – Process Duplicating – Tools for RE – Developing Technical data – Digitizing techniques – Construction of surface model – Solid part model – Characteristic evaluation – Software's and its application – CMM and its feature capturing – surface and solid modeling

UNIT - V	DATA MANAGEMENT	9

Strategies for Reverse Engineering Data management – Software application – Finding renewable software components – Recycling real time embedded software – Design experiments to evaluate a RE tools – Rule based detection for RE user interface – RE of assembly programs

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Summarize Numerical Control of machine tools and write a part program.	Apply
CO2	Explain the concepts Computer Aided Process Planning	Understand
CO3	Discuss the fundamentals of Engineering tolerance, Quality control and Inspection methods	Understand
CO4	Understand the principles behind the design of the product, ways to redesign and improve the performance of the system	Understand
CO5	Integrate strategies for Reverse Engineering Data management and evaluation of RE tools	Apply

TEXT BOOKS:

1. Catherine A. Ingle, "Reverse Engineering", Tata Mc Graw Hill Publication, 1994
2. David D. Bedworth, Mark R. Henderson, Philp M. Wolfe, "Computer Integrated Design and manufacturing", Mc Graw Hill International series, 1991

REFERENCES:

1. Donald R. Honra, "Co-ordinate measurement and reverse Engineering, American Gear Manufacturers Association
2. Ibrahim Zeid and R. Sivasubramanian, "CAD/CAM Theory and Practice", Revised First special Indian Edition, Tata Mc Graw Hill Publication, 2007
3. Ibrahim Zeid, "Mastering CAD/CAM", special Indian Edition, Tata Mc Graw Hill Publication, 2007
4. Linda Wills, "Reverse Engineering" Kluwer Academic Press, 1996

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	1	-	-	-	-	-	-	2	3
CO2	3	3	2	2	1	1	-	-	-	-	-	-	2	3
CO3	3	3	2	2	1	1	-	-	-	-	-	-	2	3
CO4	3	2	2	2	1	1	-	-	-	-	-	-	2	3
CO5	3	2	2	2	1	1	-	-	-	-	-	-	2	3
Avg.	3	3	2	2	**1**	**1**	-	-	-	-	-	-	2	3

CC24T13	ADVANCED MANUFACTURING PROCESSES	Category	L	T	P	C
		PCC	3	0	0	3

PREREQUISITE:
A prior course in basic manufacturing processes, such as machining, welding, casting, or forming, is usually required to build on these concepts in advanced techniques.

OBJECTIVES:

The Course will enable learners to:

- Analyze and determine material fabrication processes.
- Use laboratory instrument doing routine metrological measurements
- Operate regular machine shop equipment such as grinders, drill presses, lathes, milling machines, shapers and etc.
- Recognize engine machine tool requirements and be selective in the choice of tools.
- Setup and operate machines, index and determine machine speeds, feeds, and depth of cut requirements.
- Identify with numerical control machining and computer programming.

UNIT - I	SURFACE TREATMENT	9

Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapour deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

UNIT - II	NON-TRADITIONAL MACHINING	9

Introduction, need, AJM, Parametric Analysis, Process capabilities, USM–Mechanics of cutting, models, Parametric Analysis, WJM–principle, equipment, process characteristics, performance, EDM–principles, equipment, generators, analysis of R-C circuits, MRR, Surface finish, WEDM.

UNIT - III	LASER BEAM MACHINING	9

Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Plasma Arc Machining–Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Electron Beam Machining-Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Electro Chemical Machining–Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications

UNIT - IV	PROCESSING OF CERAMICS	9

Applications, characteristics, classification. Processing of particulate ceramics, Powder preparations, consolidation, Drying, sintering, Hot compaction, Area of application, finishing of ceramics. Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

UNIT - V	APPLIED QUANTUM MECHANICS	9

Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in micro electronics, surface mount technology, Integrated circuit economics. E-Manufacturing, nanotechnology, and micromachining, High speed Machining

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course the students would be able to

Course Outcome	Description	Bloom's Taxonomy Level
CO1	Understand the instrument doing routine metrological measurements	Understand
CO2	Understand the working principle of Electron beam, laser beam and laser hybrid welding processes.	Understand
CO3	Understand different types of composite material characteristics, types of micro & macro machining processes.	Apply
CO4	Understand the e-manufacturing & nano materials	Understand
CO5	Make the students get acquainted with the design for manufacturing, assembly and environment.	Apply

TEXT BOOKS:

1. Boothroyd, G,1997 Design for Assembly Automation and Product Design. NewYork, Marcel Dekker.
2. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, MarcelDekker, 2nd Edition 2002.

REFERENCES:

1. Bralla, Design for Manufacture handbook, McGrawhill,1999.
2. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.
3. Fixel, J. Design for the Environment McGrawHill.1996
4. GraedelT. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall.
5. ReasonPub.,1996.
6. Harry Peck, Designing for manufacture,Pitman–1973
7. Kevin Otto and Kristin Wood, Product Design. Pearson Publication, (Fourth Impression) 2009

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	-	-	-	-	-	-	1	2
CO2	3	2	2	2	1	1	-	-	-	-	-	-	1	3
CO3	3	2	2	2	1	1	-	-	-	-	-	-	1	3
CO4	3	2	2	2	1	1	-	-	-	-	-	-	1	3
CO5	3	2	2	2	1	1	-	-	-	-	-	-	1	3
Avg.	3	**2**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	1	2.8

RM24T19	RESEARCH METHODOLOGY AND IPR	Category	L	T	P	C
		RMC	3	0	0	3

(Common to PED, EST,CAD/CAM,ISE and CS)

PREREQUISITE:A basic understanding of academic writing and critical thinking skills to analyze research literature, familiarity with fundamental statistical concepts for data analysis, and a strong grasp of core subject knowledge relevant to the student's field. Additionally, a general awareness of legal principles related to intellectual property, ethical research practices, and innovation trends will enhance the student's ability to engage with both research methodologies and IPR concepts.

OBJECTIVES:

- To equip students with the ability to design and conduct rigorous research, employing appropriate methodologies, and critically analyzing results.
- To foster the ability to critically evaluate academic literature, identify research gaps, and formulate research questions.
- To enable students to effectively communicate research findings and legal arguments, both in written form and through presentations, to academic and professional audiences.
- To instill an understanding of ethical issues in research, including responsible conduct, data integrity, and the ethical use of intellectual property.
- To provide a comprehensive understanding of intellectual property rights, including patents, trademarks, copyrights, and their application in various industries.

UNIT - I RESEARCH DESIGN (9)

Overview of research process and design – Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies – Experiments and surveys.

UNIT - II DATA COLLECTION AND SOURCES (9)

Measurements: Measurement Scales – Questionnaires and Instruments – Sampling and Methods. Data - Preparing, Exploring, Examining and displaying.

UNIT - III DATA ANALYSIS AND REPORTING (9)

Overview of Multivariate analysis – Hypotheses testing and Measures of Association – Presenting Insights and findings using written reports and oral presentation.

UNIT - IV INTELLECTUAL PROPERTY RIGHTS (9)

Intellectual Property – The concept of IPR, Evolution and development of the concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Biodiversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT - V PATENTS (9)

Patents – objectives and benefits of patent – Concept, features of patent, Inventive step, Specification – Types of patent application, process E-filling – Examination of patent – Grant of patent, Revocation, Equitable Assignments. Licenses – Licensing of related patents – patent agents, – Registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1:	Develop a suitable research process to solve real-time problems.	Apply
CO2:	Apply appropriate methods to collect qualitative and quantitative data for analysis.	Apply
CO3:	Apply appropriate statistical tools to analyze data and solve research problems.	Apply
CO4:	Describe the types and features of intellectual property and its role in IPR establishment.	Apply
CO5:	Illustrate the patent procedures, E-filling, register of patents, and licensing of patents.	Apply

TEXT BOOKS:

1	Cooper Donald, R., Schindler Pamela, S., and Sharma, J.K., “Business Research Methods”, Tata McGraw Hill Education, Eleventh Edition, 2012.
2	Catherine J. Holland, Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets, Entrepreneur Press, 2007.

REFERENCES:

1	David Hunt, Long Nguyen, Matthew Rodgers, Patent Searching: Tools & Techniques, Wiley, 2007.
2	The Institute of Company Secretaries of India, Statutory body under an Act of Parliament, Professional Programme Intellectual Property Rights, Law and Practice, September 2013.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	-	1	1
CO2	3	3	-	1	1
CO3	3	3	-	1	1
CO4	3	3	-	1	1
CO5	3	3	-	1	1
Avg.	**3**	**3**	**-**	**1**	**1**

1 - Low, 2 - Medium, 3 - High

CC24P11	COMPUTER AIDED DESIGN LABORATORY	Category	L	T	P	C
		PCC	0	0	4	2

PREREQUISITE:
Prior exposure to basic CAD software, such as Solid Edge, AutoCAD, or SolidWorks, is usually necessary to ensure familiarity with design tools before hands-on lab work.

OBJECTIVES:
The Course will enable learners to:
- To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modeling software's

CAD Introduction.

Sketcher
Solid modeling– Extrude, Revolve, Sweep and variational sweep, Loft
Surface modeling– Extrude, Sweep, Trim and Mesh of curves, Freeform.
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/SOLIDWORKS/CATIA/NX

TOTAL= 30 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Use the modern engineering tools necessary for engineering practice	Understand
CO2	Draw 2D part drawings, sectional views, and assembly drawings as per standards	Understand
CO3	construct 3D Model on any CAD software	Apply
CO4	Convert 3D solid models into 2D drawings and prepare different views, sections, and dimensioning of part models.	Apply
CO5	Examine interference to ensure that parts will not interfere.	Analyze

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1	1	-	-	-	-	-	-	3	3
CO2	3	3	3	2	1	1	-	-	-	-	-	-	3	3
CO3	3	3	3	2	1	1	-	-	-	-	-	-	3	3
CO4	3	3	3	2	1	1	-	-	-	-	-	-	3	3
CO5	3	3	3	2	1	1	-	-	-	-	-	-	3	3
Avg.	3	3	3	2	1	1	-	-	-	-	-	-	3	3

CC24P12	COMPUTER AIDED MANUFACTURING LABORATORY	Category	L	T	P	C
		PCC	0	0	4	2

PREREQUISITE:

Basic understanding or coursework in CNC (Computer Numerical Control) machining or basic programming, as CAM systems often generate CNC code.

OBJECTIVES:

The Course will enable learners to:

- To familiarize students with manual CNC part programming for milling and turning machines.
- To generate part programs using CAM packages for milling and turning machines.
- To train students with dimensional and geometric measurements for machined features using video measuring system and coordinate measuring machine.
- To get hands on knowledge on programming logic controller - ladder programming and robot programming.
- To introduce the concept of printing parts using additive manufacturing and to introduce Relational database management system in Material requirements planning.

DETAILED SYLLABUS:

LIST OF EXPERIMENTS

1. Programming and simulation for various operations using canned cycle for CNC turning Centre.
2. Programming and simulation for machining of internal surfaces in CNC turning Centre
3. Programming and simulation for profile milling operations
4. Programming and simulation for circular and rectangular pocket milling
5. Programming and simulation using canned cycle for CNC Milling such as peck drilling and tapping cycle
6. CNC code generation using CAM software packages – Milling
7. CNC code generation using CAM software packages – Turning
8. Dimensional and geometric measurement of machined features using VMS and CMM
9. PLC ladder logic programming.
10. Robot programming for Material handling applications.
11. Study on RDBMS and its application in problems like inventory control MRP.
12. Design and fabrication of a component using extrusion based additive manufacturing.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Explain the manual CNC part programming for milling and turning machines	Understand
CO2	Draw part programs using CAM packages for milling and turning Machines	Apply
CO3	Appraise dimensional and geometric measurements of machined features using video measuring system and coordinate measuring machine	Apply

CO4	Construct PLC ladder programming and robot programming	Apply
CO5	Relate the concept of printing parts using additive manufacturing and appreciate the application RDBMS in MRP.	Understand

Mapping of COs with POs and PSOs

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	3	1	1	-	-	-	-	-	-	3	3
CO2	3	3	3	3	1	1	-	-	-	-	-	-	3	3
CO3	3	3	3	3	1	1	-	-	-	-	-	-	3	3
CO4	3	3	3	3	1	1	-	-	-	-	-	-	3	3
CO5	3	3	3	3	1	1	-	-	-	-	-	-	3	3
Avg.	**3**	**3**	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**

CC24T21	PRODUCT LIFE CYCLE MANAGEMENT	Category	L	T	P	C
		PCC	3	0		3

PREREQUISITE:
A basic understanding of design principles and processes is often required to grasp the life cycle stages of a product, from concept to disposal.

OBJECTIVES:

The Course will enable learners to:

- Understand history, concepts and terminology of PLM
- Understand functions and features of PLM/PDM
- Understand different modules offered in commercial PLM/PDM tools
- Demonstrate PLM/PDM approaches for industrial applications
- Use PLM/PDM with legacy data bases, CAx& ERP systems

UNIT - I	HISTORY,CONCEPTSAND TERMINOLOGYOF PLM	9

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM-Engineering Data Management(EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDm), Collaborative Product Commerce (CPC), Product Life cycle Management (PLM).PLM/PDM Infrastructure– Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT - II	PLM/PDM FUNCTIONS AND FEATURES	9

User Functions–Data Vault and Document Management, Work flow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions–Communication and Notification, data transport, data translation, image services, system administration and application integration

UNIT - III	DETAILS OF MODULES INAPDM/PLMSOFTWARE	9

Case studies based on top few commercial PLM/PDM tools

UNIT - IV	ROLE OF PLMININDUSTRIES	9

Case studies on PLM selection and implementation (like auto, aero, electronic)-other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM ,benefits of PLM for– business, organization, users, product or service, process performance.

UNIT - V	BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLMSOFTWARE	9

PLM Customization, use of EAI technology (Middleware), Integration with legacy database, CAD, SLM and ERP

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Summarize the history, concepts and terminology of PLM	Remember
CO2	Use the functions and features of PLM/PDM	Understand
CO3	Use different modules offered in commercial PLM/PDM tools.	Understand
CO4	Implement PLM/PDM approaches for industrial applications.	Apply
CO5	Integrate PLM/PDM with legacy data bases, CAD & ERP systems	Apply

TEXT BOOKS:

1. Antti Saaksvuori and Anselmi Immonen, "Product Lifecycle Management", Springer Publisher, 2008 (3rd Edition).
2. International Journal of Product Lifecycle Management, Inderscience Publishers

REFERENCES:

1. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, "Implementing and Integrating Product Data Management and Software Configuration Management", Artech House Publishers, 2003.
2. John Stark, "Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question", Springer Publisher, 2007.
3. John Stark, "Product Lifecycle Management: 21st Century Paradigm for Product Realisation", Springer Publisher, 2011 (2nd Edition).
4. Michael Grieves, "Product Life Cycle Management", Tata McGraw Hill, 2006.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1	1	-	-	-	-	-	-	2	2
CO2	2	2	2	2	1	1	-	-	-	-	-	-	2	2
CO3	2	2	2	2	1	1	-	-	-	-	-	-	2	2
CO4	2	2	2	2	1	1	-	-	-	-	-	-	2	2
CO5	2	2	2	2	1	1	-	-	-	-	-	-	2	2
Avg.	**2**	**2**	**2**	**2**	1	1	-	-	-	-	-	-	**2**	**2**

CC24T22	FINITE ELEMENT METHODS IN MECHANICAL DESIGN	Category	L	T		C
		PCC	3	0		3

PREREQUISITE:
A solid understanding of how materials behave under different loading conditions (stress, strain, deformation) is essential for applying FEM to mechanical design problems.

OBJECTIVES:

The Course will enable learners to:

- Learn mathematical models for one dimensional problems and their numerical solutions
- Learn two dimensional scalar and vector variable problems to determine field variables
- Learn Iso parametric transformation and numerical integration for evaluation of element matrices
- Study various solution techniques to solve Eigen value problems
- Learn solution techniques to solve non-linear problems

UNIT - I	FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS	9

Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational Formulation of B.V.P. – Ritz Method – Finite Element Modelling – Element Equations – Linear and Higher order Shape functions – Bar, Beam Elements – Applications to Heat Transfer problems.

UNIT - II	FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS	9

Basic Boundary Value Problems in two-dimensions – Linear and higher order Triangular, quadrilateral elements – Poisson’s and Laplace’s Equation – Weak Formulation – Element Matrices and Vectors – Application to scalar variable problems - Introduction to Theory of Elasticity – Plane Stress – Plane Strain and Axisymmetric Formulation – Principle of virtual work – Element matrices using energy approach.

UNIT - III	ISO-PARAMETRIC FORMULATION	9

Natural Co-ordinate Systems – Lagrangian Interpolation Polynomials – Iso parametric Elements– Formulation – Shape functions -one dimensional , two dimensional triangular and quadrilateral elements - Serendipity elements- Jacobian transformation - Numerical Integration – Gauss quadrature – one, two and three point integration.

UNIT - IV	EIGEN VALUE PROBLEMS	9

Dynamic Analysis – Equations of Motion – Consistent and lumped mass matrices – Free Vibration analysis – Natural frequencies of Longitudinal, Transverse and torsional vibration – Solution of Eigen value problems - Introduction to transient field problems

UNIT - V	NON-LINEAR ANALYSIS	9

Introduction to Non-linear problems - some solution techniques- computational procedure- material non-linearity-Plasticity and viscoplasticity, stress stiffening, contact interfaces- problems of gaps and contact - geometric non-linearity - modeling considerations - Free and Mapped meshing -Mesh quality- Error estimate.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Develop mathematical models for one dimensional problems and their numerical solutions	Understand
CO2	Determine field variables for two dimensional scalar and vector variable problems	Apply
CO3	Apply Isoparametric transformation and numerical integration for evaluation of element matrices	Apply
CO4	Apply various solution techniques to solve Eigen value problems	Apply
CO5	Formulate solution techniques to solve non-linear problems	Analyse

TEXT BOOKS:

1. Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990
2. David Hutton, "Fundamentals of Finite Element Analysis", Tata McGrawHill, 2005

REFERENCES:

1. Rao, S.S., "The Finite Element Method in Engineering", 6th Edition, Butterworth-Heinemann,2018
2. Reddy,J.N. "Introduction to the Finite Element Method", 4th Edition, TataMcGraw Hill, 2018
3. Seshu.P, "Text Book of Finite Element Analysis", PHI Learning Pvt. Ltd., New Delhi, 2012.
4. Tirupathi R. Chandrupatla and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	1	-	-	-	-	-	-	2	3
CO2	3	3	3	3	2	1	-	-	-	-	-	-	2	3
CO3	3	3	3	3	2	1	-	-	-	-	-	-	2	3
CO4	3	3	3	3	2	1	-	-	-	-	-	-	2	3
CO5	3	3	3	3	2	1	-	-	-	-	-	-	2	3
Avg.	**3**	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

CC24T23	SOLID FREEFORM MANUFACTURING	Category	L	T		C
		PCC	3	0		3

PREREQUISITE:
Understanding the properties of various materials (metals, polymers, ceramics, composites) used in additive manufacturing is critical for selecting suitable materials and processes.

OBJECTIVES:
The Course will enable learners to:

- Acquaint the students with evolution of Solid Freeform Manufacturing (SFM) / Additive Manufacturing (AM), proliferation into various fields and its effects on supply chain.
- Gain knowledge on Design for Additive Manufacturing (DFAM) and its importance in quality improvement of fabricated parts
- Acquaint with polymerization and sheet lamination processes and their applications.
- Acquaint with material extrusion and powder bed fusion processes.
- Gain knowledge on jetting and direct energy deposition processes and their applications.

UNIT - I	INTRODUCTION	9

Need - Development of SFM systems – Hierarchical structure of SFM - SFM process chain – Classification – Applications. Case studies: Bio printing- Food Printing- Electronics printing – Rapid Tooling - Building printing. AM Supply chain. Economics aspect: Strategic aspect- Operative aspect

UNIT - II	DESIGN FOR ADDITIVE MANUFACTURING	9

Concepts and Objectives - AM Unique Capabilities - Part Consolidation - Topology Optimization - Lightweight Structures - DFAM for Part Quality Improvement - CAD Modeling - Model Reconstruction - Data Processing for AM - Data Formats - Data Interfacing - Part Orientation - Support Structure Design and Support Structure Generation - Model Slicing - Tool Path Generation. Design Requirements of Additive Manufacturing: For Part Production, For Mass Production, For Series Production. Case Studies.

UNIT - III	VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES	9

Stereolithography Apparatus (SLA): Principles – Photo Polymerization of SL Resins - Pre Build Process – Part-Building and Post-Build Processes - Part Quality and Process Planning, Recoating Issues - Materials - Advantages - Limitations and Applications. Digital Light Processing (DLP) - Materials - Process - Advantages and Applications.

Laminated Object Manufacturing (LOM): Working Principles - Process - Materials, Advantages, Limitations and Applications. Ultrasonic Additive Manufacturing (UAM) - Process - Parameters - Applications. Case Studies.

UNIT - IV	MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES	9

Fused deposition Modeling (FDM): Working Principles - Process - Materials and Applications. Design Rules for FDM. Selective Laser Sintering (SLS): Principles - Process - Indirect and Direct SLS - Powder Structure – Materials - Surface Deviation and Accuracy - Applications. Multi jet Fusion. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Principles – Processes – Materials – Advantages - Limitations and Applications. Case Studies.

UNIT - V	JETTING AND DIRECT ENERGY DEPOSITION PROCESSES	9

Binder Jetting: Three dimensional Printing (3DP): Principles – Process - Physics of 3DP - Types of printing: Continuous mode – Drop on Demand mode - Process – Materials - Advantages - Limitations - Applications. Material Jetting: Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

Laser Engineered Net Shaping (LENS): Processes- Materials- Advantages - Limitations and Applications. Case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Relate the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain.	Understand
CO2	Analyze the design for AM and its importance in the quality of fabricated parts	Analyse
CO3	Build knowledge on principles and applications of polymerization and sheet lamination processes with case studies	Understand
CO4	Explain the principles of material extrusion and powder bed fusion processes and design guidelines	Understand
CO5	Elaborate jetting and direct energy deposition processes and their applications.	Understand

TEXT BOOKS:

1. Andreas Gebhardt and Jan-Steffen Hotter, "Additive Manufacturing:3D Printing for Prototyping and Manufacturing", Hanser publications Munchen, Germany, 2016. ISBN:978-1-56990-582-1.
2. Ben Redwood, Brian Garret, FilemonSchöffer, and Tony Fadel, "The 3D Printing Handbook Technologies, Design and Applications", 3D Hubs B.V., Netherland, 2017. ISBN-13: 978-9082748505.

REFERENCES:

1. Ian Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer - New York, USA, 2nd Edition, 2015. ISBN-13: 978-1493921126.
2. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 1st Edition, 2007 FL, USA. ISBN- 9780849334092.
3. Milan Brandt., "Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, and Applications", Woodhead Publishing, UK, 2016. ISBN- 9780081004333.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	3
CO2	3	2	2	-	-	-	-	-	-	-	-	2	2	3
CO3	3	-	-	-	-	-	-	-	-	-	-	-	2	3
CO4	3	-	-	-	-	-	-	-	-	-	-	-	2	3
CO5	3	-	-	-	-	-	-	-	-	-	-	-	2	3
Avg.	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**

CC24T24	INDUSTRY 4.0	Category	L	T		C
		PCC	3	0		3

PREREQUISITE:
Prior exposure to Cyber-Physical Systems (CPS), IoT, or smart systems can be beneficial, as these are core components of Industry 4.0.

OBJECTIVES:

The Course will enable learners to:
- Understand Industry 4.0
- Apply IOT and IIOT for Industry 4.0
- Understand CPS for Industry 4.0

UNIT - I	INTRODUCTION	9

Introduction to Industry 4.0 The Various Industrial Revolutions - Digitalisation and the Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 - Comparison of Industry 4.0 Factory and Today's Factory - Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation

UNIT - II	IOT AND IIOT FOR INDUSTRY 4.0	9

Road to Industry 4.0 - Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services - Smart Manufacturing - Smart Devices and Products - Smart Logistics - Smart Cities - Predictive Analytics.

UNIT - III	TECHNOLOGIES FOR INDUSTRY 4.0	9

System, Technologies for enabling Industry 4.0–Cyber Physical Systems - Robotic Automation and Collaborative Robots - Support System for Industry 4.0 - Mobile Computing - Cyber Security.

UNIT - IV	INFORMATION SHARING IN ORGANISATIONS	9

Role of data, information, knowledge and collaboration in future organizations - Resource- based view of a firm - Data as a new resource for organizations - Harnessing and sharing knowledge in organizations - Cloud Computing Basics -Cloud Computing and Industry 4.0

UNIT - V	OPPORTUNITIES AND CHALLENGES	9

Industry 4.0 IIoT case studies - Opportunities and Challenges - Future of Works and Skills for Workers in the Industry 4.0 Era - Strategies for competing in an Industry 4.0 world – Society 5.0

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Use Industry 4.0 for Industrial Applications	Understand
CO2	Use IoT and IIoT for Industry 4.0	Understand
CO3	Apply smart devices Industrial Applications	Apply
CO4	Apply information, knowledge for organizations	Apply
CO5	Know the Opportunities and Challenges	Understand

TEXT BOOKS:

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things

REFERENCES:

1. Arsheep Bahga, Internet of Things: A Hands-On Approach

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1	1	-	-	-	-	-	-	2	2
CO2	2	2	2	2	1	1	-	-	-	-	-	-	2	2
CO3	2	2	2	2	1	1	-	-	-	-	-	-	2	2
CO4	2	2	2	2	1	1	-	-	-	-	-	-	2	2
CO5	2	2	2	2	1	1	-	-	-	-	-	-	2	2
Avg.	**2**	**2**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**

CC24P21	RAPID PROTOTYPING LABORATORY	Category	L	T	P	C
		PCC	0	0	4	2

PREREQUISITE:
A background in basic manufacturing processes, including machining, casting, or additive manufacturing (e.g., 3D printing), helps students understand how prototypes are produced in real-world settings.

OBJECTIVES:
The Course will enable learners to:

- To provide facilities for computer-aided design (CAD), manufacturing (CAM), rapid prototyping of solid models, and dimensional accuracy and inspection.

DETAILED SYLLABUS:

1. Review of CAD Modeling Techniques and Introduction to RP
2. Forming Groups & Assigning Creative Idea
3. Generating STL files from the CAD Models & Working on STL files
4. Modeling Creative Designs in CAD Software
5. Assembling Creative Designs in CAD Software
6. Processing the CAD data in Catalyst software (Selection of Orientation, Supports generation, Slicing, Tool path generation)
7. Sending the tool path data to FDM RP machine
8. Removing the supports & post processing (cleaning the surfaces)
9. Demonstrating Creative Working Models

TOTAL: 30 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Design the models in CAD software	Apply
CO2	Optimize the process parameters of FDM machine to improve the quality of the parts produced.	Analyze
CO3	Build complex engineering assemblies in plastic material with less process planning.	Apply
CO4	Improve surface finish of fabricated plastic components for the Engineering applications.	Analyze
CO5	Design and fabricate working models for the conceptual testing applications.	Apply

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1	1	-	-	-	-	-	-	2	2
CO2	3	3	3	3	1	1	-	-	-	-	-	-	2	2
CO3	3	3		3	1	1	-	-	-	-	-		2	
CO4	3	3	3	2	1	1	-	-	-	-	-	-	2	2
CO5	3	3	3	2	1	1	-	-	-	-	-	-	2	2
Avg.	**3**	**3**	**3**	**2**	**1**	**1**	-	-	-	-	-	-	**2**	**2**

CC24P22	SIMULATION AND ANALYSIS LABORATORY	Category	L	T	P	C
		PCC	0	0	4	2

PREREQUISITE:
A background in numerical analysis or computational methods is important since simulations often use these techniques to solve complex problems.

OBJECTIVES:
The Course will enable learners to:
- Give exposure to software tools needed to analyze engineering problems.

LIST OF EXPERIMENTS
1. Force and Stress analysis using link elements in Trusses.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates.
4. Stress analysis of axi–symmetric components.
5. Thermal stress and heat transfer analysis of plates.
6. Thermal stress analysis of cylindrical shells
7. Vibration analysis of spring-mass systems.
8. Modal analysis of Beams.
9. Harmonic, transient and spectrum analysis of simple systems.
10. Analysis of machine elements under dynamic loads.
11. Analysis of non-linear systems

TOTAL: 30 PERIODS

Course Outcome	Description	Bloom's Taxonomy Level
CO1	Solve engineering problems numerically using Computer Aided Finite Element Analysis packages	Understand
CO2	Analyze the force, stress, deflection in mechanical components	Analysis
CO3	Analyze thermal stress and heat transfer in mechanical components.	Analysis
CO4	Analyze the vibration of mechanical components.	Analysis
CO5	Analyze the modal, harmonic, transient and spectrum concepts in mechanical components	Analysis

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	-	-	-	-	-	-	-	2	-	3
CO2	3	3	3	3	-	-	-	-	-	-	-	2	-	3
CO3	3	3	3	2	-	-	-	-	-	-	-	2	-	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	3	-
CO5	3	3	3	3	-	-	-	-	-	-	-	2	-	3
Avg.	3	2.8	3	2.6	-	-	-	-	-	-	-	2	3	3

CC24E01	INTEGRATED PRODUCT DEVELOPMENT	Category	L	T		C
		PEC	3	0		3

PREREQUISITE:
Student must Know the basic design principles and processes are crucial for understanding how different aspects of product development are integrated.

OBJECTIVES:

The Course will enable learners to:

- Understand the principles of generic development process; product planning; customer need analysis for new product design and development.
- Enhance the understanding of setting product specifications and generate, select, screen, and test concepts for new product design and development.
- Apply the principles of product architecture and the importance of industrial design principles and DFM principles for new product development.
- Expose the different Prototyping techniques, Design of Experiment principles to develop a robust design and importance to patent a developed new product.
- Applying the concepts of economics principles; project management practices in development of new product.

UNIT - I	INTRODUCTION TO PRODUCT DESIGN	9

Characteristics of Successful Product development –Duration and Cost of Product Development – Challenges of Product Development - Product Development Processes and Organizations – Product Planning Process - Process of Identifying Customer Needs.

UNIT - II	PRODUCT SPECIFICATIONS, CONCEPT GENERATION, SELECTION AND TESTING	9

Establish Target and Final product specifications – Activities of Concept Generation - Concept. Screening and Scoring - Concept Testing Methodologies

UNIT - III	PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN	9

Product Architecture – Implications and establishing the architecture – Delayed Differentiation – Platform Planning – Related system level design issues - Need and impact of industrial design - Industrial design process - management of the industrial design process - assessing the quality of industrial design

UNIT - IV	DESIGN FOR MANFACTURE, PROTOTYPING AND ROBUST DESIGN	9

DFM Definition - Estimation of Manufacturing cost- Reducing the component costs, costs of supporting function and assembly costs – Impact of DFM decision on other factors - Prototype basics - Principles of prototyping – Prototyping technologies - Planning for prototypes - Robust design –Robust Design Process

UNIT - V	PRODUCT DEVELOPMENTECONOMICS AND MANAGING PROJECTS	9

Economic Analysis – Elements of Economic Analysis - Understanding and representing tasks- Baseline Project Planning - Accelerating the project - Project execution – Postmortem project evaluation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Apply the principles of generic development process; product planning; customer need analysis for new product design and development.	Apply
CO2	Set product specifications and generate, select, screen, test concepts for new product design and development	Understand
CO3	Apply the principles of product architecture, industrial design and design for manufacturing principles in new product development	Apply
CO4	Apply the adopt Prototyping techniques and Design of Experiment principles to develop a robust design and document a new product for patent	Apply
CO5	Apply the Elements of Economic analysis and design a product	Apply

TEXT BOOKS:

1. Karl T.Ulrich, Steven D. Eppinger, Anita Goyal, "Product Design and Development", McGraw –Hill Education (India) Pvt. Ltd, 4th Edition, 2012.
2. Kenneth Crow, "Concurrent Engineering/Integrated Product Development". DRM Associates, 6/3,ViaOlivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book

REFERENCES:

1. Kevin N Otto, Kristin L Wood, "Product Design – Techniques in Reverse Engineering and New Product Development", Pearson Education, Inc, 2016
2. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwi Homewood, 1992
3. Stuart Pugh, "Total Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, Neyourk, NY, 1991

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1	1	-	-	-	-	-	-	2	3
CO2	3	3	3	2	1	1	-	-	-	-	-	-	2	3
CO3	3	3	3	2	1	1	-	-	-	-	-	-	2	3
CO4	3	3	3	2	1	1	-	-	-	-	-	-	2	3
CO5	3	3	3	2	1	1	-	-	-	-	-	-	2	3
Avg.	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

<table>
<tr><td rowspan="2">CC24E02</td><td rowspan="2">COMPOSITE MATERIALS AND MECHANICS</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>PEC</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">PREREQUISITE:
A solid understanding of the properties and behaviors of different materials, including metals, polymers, and ceramics, is essential for grasping the concepts of composite materials.</td></tr>
<tr><td colspan="7">OBJECTIVES:
The Course will enable learners to:
• Study of different composite materials and finding its mechanical strength
• Fabrication of FRP and other composites by different manufacturing methods
• Stress analysis of fiber reinforced Laminates for different combinations of plies with different orientations of the fiber.
• Calculation of stresses in the lamina of the laminate using different failure theories
• Calculation of residual stresses in different types of laminates under thermo-mechanical load using the Classical Laminate Theory.</td></tr>
<tr><td>UNIT - I</td><td colspan="5">INTRODUCTION TO COMPOSITE MATERIALS</td><td>9</td></tr>
<tr><td colspan="7">Definition-Matrix materials-polymers-metals-ceramics - Reinforcements: Particles, whiskers, inorganic fibers, metal filaments-ceramic fibers-fiber fabrication-natural composite wood, Jute-Advantages and drawbacks of composites over monolithic materials. Mechanical properties and applications of composites, Particulate-Reinforced composite Materials, Dispersion-Strengthened composite, Fiber-reinforced composites Rule of mixtures-Characteristics of fiber-Reinforced composites, Manufacturing fiber and composites</td></tr>
<tr><td>UNIT - II</td><td colspan="5">MANUFACTURING OF COMPOSITES</td><td>9</td></tr>
<tr><td colspan="7">Manufacturing of Polymer Matrix Composites (PMCs)-handlay-up, spray technique, filament winding, Pultrusion, Resin Transfer Moulding (RTM)-,bag moulding, injection moulding, Sandwich Mould Composites (SMC) - Manufacturing of Metal Matrix Composites (MMCs) - Solid state, liquid state, vapour state processing, Manufacturing of Ceramic Matrix Composites (CMCs)–hot pressing- reaction bonding process-infiltration technique, directoxidation-interfaces</td></tr>
<tr><td>UNIT - III</td><td colspan="5">LAMINA CONSTITUTIVE EQUATIONS</td><td>9</td></tr>
<tr><td colspan="7">Lamina Constitutive Equations: Lamina Assumptions–Macroscopic View point. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle PlyLaminates, CrossPly Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates</td></tr>
<tr><td>UNIT - IV</td><td colspan="5">LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES</td><td>9</td></tr>
<tr><td colspan="7">Introduction- Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial(Tsai-Wu) Failure criterion. Prediction of laminate Failure Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations– Natural Frequencies</td></tr>
<tr><td>UNIT - V</td><td colspan="5">THERMO-STRUCURAL ANALYSIS</td><td>9</td></tr>
<tr><td colspan="7">Fabrication stresses / Residual stresses in FRP laminated composites-Co-efficient of Thermal Expansion (C.T.E.) - Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's -Stress and Moment Resultants due cooling of the laminates during fabrication-Calculations for thermo-mechanical stresses in FRP laminates
Case studies: Implementation of CLT for evaluating residual stresses in the components made with</td></tr>
</table>

different isotropic layers such as electronic packages etc

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Calculate for mechanical strength of the composite material	Apply
CO2	Fabricate the FRP and other composites by different manufacturing methods	Understand
CO3	Analyze fiber reinforced Laminates for different combinations of plies with different orientations of the fiber	Analyze
CO4	Apply the stresses in the lamina of the laminate using different failure theories	Apply
CO5	Analyze thermo-mechanical behavior and evaluate residual stresses in different types of laminates using the Classical Laminate Theory	Analyze

TEXT BOOKS:
1. Agarwal BD and Broutman LJ,"Analysis and Performance of Fiber Composites", John Wiley and Sons, New York,1990.
2. Gibson RF, Principles of Composite Material Mechanics, CRC press, 4th Edition, 2015

REFERENCES:
1. Hyer MW and Scott R White, "Stress Analysis of Fiber – Reinforced Composite Materials",McGraw-Hill,1998
2. Issac M Daniel and OriI shai, "Engineering Mechanics of Composite Materials", OxfordUniversityPress-2006,FirstIndian Edition-2007
3. Madhujit Mukhopadhyay,"Mechanics of Composite Materials and Structures", University Press(India)Pvt.Ltd.,Hyderabad,2004(Reprinted 2008)
4. Mallick PK, Fiber – Reinforced Composites: Materials, Manufacturing and Design, CRC Press, 3rd Edition,2007.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	2	2	-	-	-	-	-	-	2	3
CO2	3	1	1	1	2	2	-	-	-	-	-	-	2	3
CO3	3	1	1	1	2	2	-	-	-	-	-	-	2	3
CO4	3	1	1	1	2	2	-	-	-	-	-	-	2	3
CO5	3	1	1	1	2	2	-	-	-	-	-	-	2	3
Avg.	**3**	**1**	**1**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

CC24E03	COMPUTER CONTROL IN PROCESS PLANNING	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

Understanding various manufacturing techniques and processes is essential, as computer control systems are used to plan and optimize these processes.

OBJECTIVES:

The Course will enable learners to:

- Study about process planning in manufacturing cycle and Concurrent Engineering
- Understand the concept and principle behind part design.
- Get knowledge on process engineering and process planning
- Study the application of Computer Aided Process Planning tool in the present manufacturing scenario
- provide the student with an understanding of the importance of process planning role in manufacturing

UNIT - I	INTRODUCTION	9

The Place of Process Planning in the Manufacturing cycle-ProcessPlanningandProductionPlanning–ProcessPlanningandConcurrentEngineering,CAPP,GroupTechnology

UNIT - II	PART DESIGN REPRESENTATION	9

Design Drafting - Dimensioning - Conventional tolerance - Geometric tolerance - CAD - input /output devices - topology- Geometric transformation- Perspective transformation –Data structure - Geometric modelling for process planning- GT coding - The optiz system - The MICLASS System.

UNIT - III	PROCESS ENGINEERING AND PROCESS PLANNING	9

Experienced, based planning - Decision table and decision trees - Process capability analysis - Process Planning - Variant process planning - Generative approach - Forward and Backward planning, Input format, Al

UNIT - IV	COMPUTER AIDED PROCESS PLANNING SYSTEMS	9

Logical Design of a Process Planning - Implementation considerations -manufacturing system components, production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

UNIT - V	AN INTERGRADED PROCESS PLANNING SYSTEMS	9

Totally integrated process planning systems - An Overview - Modulus structure - Data Structure, operation – Report Generation, Expert process planning

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	To understand the need of process planning in manufacturing	Understand
CO2	To know handle the computer aided process planning tool	Understand
CO3	ToapplytheknowledgeofExpertsystems,Grouptechnologyandpartrepresentationfor various applications	Apply
CO4	To interpret the use of computer aided process panning for CAD/CAM Systems	Understand
CO5	To analyse the computer aided planning systems for various industrial applications	Analyze

TEXT BOOKS:

1. Chang, T.C., "An Expert Process Planning System ", Prentice Hall,1985.
2. Gideon Halevi and Roland D.Weill, "Principles of Process Planning", A logical approach, Chapman &Hall,1995.

REFERENCES:

1. Nanua Singh, "Systems Approach to Computer Integrated Design and Manufacturing", John Wiley & Sons, 1996.
2. Rao, "Computer Aided Manufacturing", Tata Mc Graw Hill Publishing Co.,2000.
3. Tien-Chien Chang, Richard A. Wysk, "An Introduction to automated process planning systems", Prentice Hall,1985.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1	1	1	-	-	-	-	-	-	1	3
CO2	3	3	3	1	1	1	-	-	-	-	-	-	1	3
CO3	3	3	3	1	1	1	-	-	-	-	-	-	1	3
CO4	3	3	3	1	1	1	-	-	-	-	-	-	1	3
CO5	3	3	3	1	1	1	-	-	-	-	-	-	1	3
Avg.	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**

CC24E04	ADVANCED FINITE ELEMENT ANALYSIS	Category	L	T		C
		PEC	3	0		3

PREREQUISITE:
Advanced mathematical skills are necessary for understanding the complex algorithms and models used in advanced FEA

OBJECTIVES:
The Course will enable learners:

- To study concept of Finite Element Analysis to solve problems involving plate and shell elements
- To learn concept of Finite Element Analysis to solve problems involving geometric and material non linearity
- To study solution techniques to solve dynamic problems
- To study the concepts of Finite Element Analysis to solve fluid mechanics and heat transfer problems
- To study error norms, convergence rates and refinement.

UNIT - I	BENDING OF PLATES AND SHELLS	9

Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non-Conforming Elements – C0 and C1 Continuity Elements –Degenerated shell elements-Application and Examples

UNIT - II	NON-LINEAR PROBLEMS	9

Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity – Visco Plasticity – Geometric Non linearity – large displacement Formulation –Solution procedure-Application in Metal Forming Process and Contact Problems

UNIT - III	DYNAMIC PROBLEM	9

Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Sub space Iterative Technique – Response analysis - Houbolt, Wilson, Newmark– Methods – Explicit & Implict Methods-Lanchzos, Reduced method for large size system equations

UNIT - IV	FLUID MECHANICS AND HEAT TRANSFER	9

Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming–Navier Stokes Equation–Steady and Transient Solution.

UNIT - V	ERROR ESTIMATES AND ADAPTIVE REFINEMENT	9

Error norms and Convergence rates–h-refinement with adaptivity–Adaptive refinement

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Apply concept of Finite Element Analysis to solve problems involving plate and shell elements	Apply
CO2	Apply concept of Finite Element Analysis to solve problems involving geometric and material non linearity	Apply
CO3	Formulate solution techniques to solve dynamic problems	Understand
CO4	Apply concepts of Finite Element Analysis to solve fluid mechanics and heat transfer problems	Apply
CO5	Investigate error norms, convergence rates and refinement	Understand

TEXT BOOKS:

1. Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall,1990
2. Logan. D. L.,"A first course in Finite Element Method", Cengage Learning, 2012

REFERENCES:

1. Reddy, J.N. "An Introduction to Non linear Finite Element Analysis", 2nd Edition, Oxford, 2015
2. Robert D.Cook, David S.Malkus, Michael E.Plesha, Robert J.Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2004.
3. Tirupathi R. Chandrupatla and Ashok D.Belegundu,"Introduction to Finite Elements in
4. Engineering",InternationalEdition,PearsonEducationLimited,2014.
5. Zienkiewicz, O. C., Taylor, R. L. and Zhu. J .Z. ,"The Finite Element Method: Its Basis and
6. Fundamentals",7th Edition, Butterworth-Heinemann,2013

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	1	1	-	-	-	-	-	-	2	3
CO2	3	3	3	3	1	1	-	-	-	-	-	-	2	3
CO3	3	3	3	3	1	1	-	-	-	-	-	-	2	3
CO4	3	3	3	3	1	1	-	-	-	-	-	-	2	3
CO5	3	3	3	3	1	1	-	-	-	-	-	-	2	3
Avg.	**3**	**3**	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

CC24E05	OPTIMIZATION TECHNIQUES IN DESIGN	Category	L	T		C
		PEC	3	0		3

PREREQUISITE:
Understanding basic principles of design and design processes is essential, as optimization techniques are applied to improve and refine designs.

OBJECTIVES:

The Course will enable learners:

- To understand the basic concepts of unconstrained optimization techniques.
- To understand the basic concepts of constrained optimization techniques.
- To provide the mathematical foundation of artificial neural networks and swarm intelligence for design problems.
- To implement optimization approaches and to select appropriates solution for design application.
- To demonstrate selected optimization algorithms commonly used in static and dynamic applications.

UNIT - I	UNCONSTRAINED OPTIMIZATION TECHNIQUES	9

Introduction to optimum design - General principles of optimization – Problem formulation & their classifications- Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.

UNIT - II	CONSTRAINED OPTIMIZATION TECHNIQUES	9

Optimization with equality and inequality constraints-Direct methods–Indirect methods using penalty functions, Lagrange multipliers-Geometric programming.

UNIT - III	ARTIFICIAL NEURAL NETWORKS AND SWARM INTELLIGENCE	9

Introduction–Activation functions, types of activation functions, neural network architectures, Single layer feed forward network, multi layer feed forward network, Neural network applications.
Swarm intelligence-Various animal behaviors, Ant Colony optimization, Particle Swarm optimization

UNIT - IV	ADVANCED OPTIMIZATION TECHNIQUES	9

Multistage optimization–dynamic programming, stochastic programming Multi objective optimization Genetic algorithms and Simulated Annealing technique

UNIT - V	STATIC AND DYNAMIC APPLICATIONS	9

Structural applications – Design of simple truss members – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs. Dynamic Applications – Optimum design of single, two degree of freedom systems, vibrationabsorbers.ApplicationinMechanisms–Optimumdesignofsimplelinkagemechanisms.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Formulate unconstrained optimization techniques in engineering design application	Understand
CO2	Formulate constrained optimization techniques for various applications	Apply
CO3	Implement neural network technique to real world design problems	Apply
CO4	Apply genetic algorithms to combinatorial optimization problems	Apply
CO5	Apply solutions by various optimization approaches for a design problem	Apply

TEXT BOOKS:

1. Goldberg, David. E, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson, 2009.
2. Jang, J. S.R, Sun,C. T and Mizutani E. "Neuro-Fuzzy and Soft Computing", PearsonEducation.2015

REFERENCES:

1. Johnson Ray,C.,"Optimumdesignofmechanicalelements",Wiley,2nd Edition1980
2. Kalyanmoy Deb,"Optimization for Engineering Design: Algorithms and Examples", PHIL earningPrivateLimited,2nd Edition,2012
3. Rao Singiresu S., "Engineering Optimization – Theory and Practice", New Age International Limited,NewDelhi,3rdEdition,2013
4. Rajasekaran S and Vijayalakshmi Pai, G.A, "Neural Networks, Fuzzy Logic andGeneticAlgorithms",PHI,2011

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	3	1	1	-	-	-	-	-	-	2	3
CO2	3	2	3	3	1	1	-	-	-	-	-	-	2	3
CO3	3	2	3	3	1	1	-	-	-	-	-	-	2	3
CO4	3	2	3	3	1	1	-	-	-	-	-	-	2	3
CO5	3	2	3	3	1	1	-	-	-	-	-	-	2	3
Avg.	**3**	**2**	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

CC24E06	ADVANCED MACHINE TOOL DESIGN	Category	L	T		C
		PEC	3	0		3

PREREQUISITE:
Understanding material behavior under different loading conditions is important for designing robust and efficient machine tools.

OBJECTIVES:

The Course will enable learners to:
- Selecting the different machine tool mechanisms.
- Designing the Multi speed Gear Box and feed drives.
- Designing the machine tool structures.
- Designing the guide ways and power screws.
- Designing the spindles and bearings.

UNIT - I	INTRODUCTION TO MACHINE TOOL DESIGN	9

Introduction to Machine Tool Drives and Mechanisms, Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission

UNIT - II	REGULATION OF SPEEDS AND FEEDS	9

Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design

UNIT - III	DESIGN OF MACHINE TOOL STRUCTURES	9

Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriage

UNIT - IV	DESIGN OF GUIDEWAYS AND POWER SCREWS	9

Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slide ways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws

UNIT - V	DESIGN OF SPINDLES AND SPINDLE SUPPORT	9

Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings. Dynamics of Machine Tools: Machine Tool Elastic System, Static and Dynamic Stiffness

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Select the different machine tool mechanisms	Understand
CO2	Design the Multi speed Gear Box and feed drives	Apply
CO3	Design the machine tool structures	Apply
CO4	Design the guideways and power screws	Apply
CO5	Design the spindles and bearings	Apply

TEXT BOOKS:

1. N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 3rd edition 2012
2. G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2015

REFERENCES:

1. K Pal, S. K. Basu, "Design of Machine Tools", 6th Edition. Oxford IBH, 2014
2. N. S. Acherkhan, "Machine Tool Design", Volume 2 University Press of the Pacific, 2000
3. F. Koenigsberger, Design Principles of Metal-Cutting Machine Tools, Pergamon Press, 1964
4. F. Koenigsberger, Machine Tool Structures, Pergamon Press,1970.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1	1	1	-	-	-	-	-	-	2	2
CO2	3	3	3	1	1	1	-	-	-	-	-	-	2	2
CO3	3	3	3	1	1	1	-	-	-	-	-	-	2	2
CO4	3	3	3	1	1	1	-	-	-	-	-	-	2	2
CO5	3	3	3	1	1	1	-	-	-	-	-	-	2	2
Avg.	**3**	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**

CC24E07	REVERSE ENGINEERING	Category	L	T		C
		PEC	3	0		3

PREREQUISITE:
Basic knowledge of engineering design principles and processes is important, as reverse engineering often involves recreating or improving existing designs.

OBJECTIVES:
The Course will enable learners to:

- Applying the fundamental concepts and principles of reverse engineering in product design and development.
- Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Applying the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
- Analyzing the various legal aspect and applications of reverse engineering in product design and development

UNIT - I	INTRODUCTION TO REVERSE ENGINEERING & GEOMETRIC FORM	9

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping

UNIT - II	MATERIAL CHARACTERISTICS, PART DURABILITY AND LIFE LIMITATION	9

Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure

UNIT - III	MATERIAL IDENTIFICATION AND PROCESS de VERIFICATION	9

Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification

UNIT - IV	DATA PROCESSING, PART PERFORMANCE AND SYSTEM COMPATIBILITY	9

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility

UNIT - V	ACCEPTANCE, LEGALITY AND INDUSTRIAL APPLICATIONS OF RE	9

Legality of Reverse Engineering – Patent – Copyrights –Trade Secret – Third-Party Materials – Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Apply the fundamental concepts and principles of reverse engineering in product design and development.	Apply
CO2	Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development	Apply
CO3	Apply the concept and principles of material identification and process verification in reverse engineering of product design and development	Apply
CO4	Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development	Apply
CO5	Analyze the various legal aspect and applications of reverse engineering in product design and development	Analyze

TEXT BOOKS:

1. Co-ordinate Measurement and reverse engineering, Donald R. Honsa, ISBN 1555897, American Gear Manufacturers Association
2. Data Reverse Engineering, Aiken, Peter, McGraw-Hill, 1996

REFERENCES:

1. Design Recovery for Maintenance and Reuse, T J Biggerstaff, IEEE Corpn. July 1991
2. Reverse Engineering, Katheryn, A. Ingle, McGraw-Hill, 1994
3. Reverse Engineering, Linda Wills, Kluiver Academic Publishers, 1996
4. White paper on RE, S. Rugaban, Technical Report, Georgia Instt. of Technology, 1994

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	1	1	-	-	-	-	-	-	2	2
CO2	3	3	2	1	1	1	-	-	-	-	-	-	2	2
CO3	3	3	2	1	1	1	-	-	-	-	-	-	2	2
CO4	3	3	2	1	1	1	-	-	-	-	-	-	2	2
CO5	3	3	2	1	1	1	-	-	-	-	-	-	2	2
Avg.	**3**	**3**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**

CC24E08	INDUSTRIAL SAFETY MANAGEMENT	Category	L	T		C
		PEC	3	0		3

PREREQUISITE:
Basic understanding of engineering safety principles and practices is crucial for grasping advanced topics in industrial safety management.

OBJECTIVES:
The Course will enable learners to:

- Achieve an understanding of principles of safety management.
- Enable the students to learn about various functions and activities of safety department.
- Have knowledge about sources of information for safety promotion and training
- Have knowledge on accident prevention techniques and its equipments
- Familiarize students with evaluation of safety performance.

UNIT - I	SAFETY MANAGEMENT	9

Evaluation of modern safety concepts- Safety management functions- safety organization, safety department-safety committee, safety audit-performance measurements and motivation-employee participation in safety-safety and productivity

UNIT - II	OPERATIONAL SAFETY	9

Hot metal Operation-Boiler, pressure vessels- heat treatment shop- gas furnace operation-electroplating-hot bending pipes - Safety in welding and cutting. Cold-metal Operation - Safety in Machineshop-Coldbendingandchamferingofpipes-metalcutting-shotblasting, grinding, painting-power press and other machines

UNIT - III	SAFETY MEASURES	9

Layout design and material handling – Use of electricity – Management of toxic gases and chemicals, Industrial fires and prevention - Road safety - highway and urban safety - Safety of sewage disposal and cleaning - Control of environmental pollution - Managing emergencies in Industries- planning, security and risk assessments, on-site and offsite. Control of major industrial hazards

UNIT - IV	ACCIDENTPREVENTION	9

Human side of safety - personal protective equipment - Causes and cost of accidents. Accident prevention programmes - Specific hazard control strategies - HAZOP - Training and development of employees-First Aid-Fire fighting devices-Accident reporting, investigation.

UNIT - V	SAFETY,HEALTH,WELFARE & LAWS	9

Safety and health standards - Industrial hygiene - occupational diseases prevention – Welfare facilities-History of legislations related to Safety-pressure vessel act-Indian boileract-The environmental protection act-Electricity act-Explosive act

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:		
Course Outcomes	**Description**	**Bloom's Taxonomy Level**
CO1	To understand the functions and activities of safety engineering department.	Understand
CO2	To carry out a safety audit and prepare a report for the audit.	Understand
CO3	To prepare an accident investigation report.	Understand
CO4	To estimate the accident cost using supervisors report and data.	Understand
CO5	To Analyze the safety performance of an organization from accident records.	Analyze

TEXT BOOKS:

1. Ray Asfahl. C "Industrial Safety and Health Management" Pearson Prentice Hall, 2003.
2. Blake R.B., "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973.

REFERENCES:

1. John V.Grimaldi and Rollin H. Simonds, "Safety Management", Richard D Irwin, 1994.
2. Dan Petersen, "Techniques of Safety Management", McGraw-Hill Company, Tokyo, 1981.
3. Philip Hagan, "Accident Prevention Manual for Business and Industry", N.S.C.Chicago, 13^{th}edition, 2009.
4. Lees, F.P & M. Sam Mannan, "Loss Prevention in Process Industries: Hazard Identification, Assessment and Control", Butterworth-Heinemann publications, London, 4th edition, 2012.
5. John Ridley, "Safety at Work", Butterworth and Co., London, 1983.
6. Subramanian.V., "The Factories Act 1948 with Tamilnadu factories rules 1950", Madras BookAgency, 21st ed., Chennai, 2000.
7. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980.
8. Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	-	-	-	-	-	-	2	2
CO2	3	2	1	1	1	1	-	-	-	-	-	-	2	2
CO3	3	2	1	1	1	1	-	-	-	-	-	-	2	2
CO4	3	2	1	1	1	1	-	-	-	-	-	-	2	2
CO5	3	2	1	1	1	1	-	-	-	-	-	-	2	2
Avg.	**3**	**2**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**

CC24E09	MECHANICAL MEASUREMENTS AND ANALYSIS	Category	L	T	P	C
		PEC	3	0		3

PREREQUISITE:
Prior exposure to basic measurement principles and techniques is necessary, including knowledge of measurement tools and instrumentation.

OBJECTIVES:
The Course will enable learners to:

- Understand the principle of force and strain measurement.
- Understand the vibration measurement and their applications.
- Impart knowledge on the principle behind acoustics and wind flow measurements.
- Familiarize with the distress measurements
- Realize the non destructive testing principle and application

UNIT - I	FORCES AND STRAIN MEASUREMENT	9

Strain gauge, principle, types, performance and uses. Photo elasticity–Principle and applications - Moire Fringe-Hydraulic jacks and pressure gauges–Electronic load cells–Proving Rings–Calibration of Testing Machines

UNIT - II	VIBRATION MEASUREMENTS	9

Characteristics of Structural Vibrations–Linear Variable Differential Transformer(LVDT)– Transducers for velocity and acceleration measurements. Vibration meter– Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters–Digital data Acquisition systems

UNIT - III	ACOUSTICS AND WIND FLOW MEASUREMENTS	9

Principles of Pressure and flow measurements–pressure transducers–sound level meter–venturimeter and flow meters–wind tunnel and its use in structural analysis–structural modeling – direct and indirect model analysis

UNIT - IV	DISTRESS MEASUREMENTS	9

Diagnosis of distress in structures–crack observation and measurements–corrosion of reinforcement in concrete – Half-cell, construction and use – damage assessment – controlled blasting for demolition

UNIT - V	NON DESTRUCTIVE TESTING METHODS	9

Load testing on structures, buildings ,bridges and towers–Rebound Hammer –acoustice mission – ultrasonic testing principles and application–Holography–use of laser for structural testing–Brittle coating

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Measure physical quantities such as forces and strains	Understand
CO2	Apply different vibration measurements techniques	Apply
CO3	Measure physical quantities such as pressure and flow	Understand
CO4	Apply techniques involved in crack measurement.	Apply
CO5	Select the appropriate nondestructive testing methods for various engineering applications.	Apply

TEXT BOOKS:

1. Bray DonE and Stanley, R.K., "Non-destructive Evaluation", McGraw Hill Publishing Company, N.Y.1989
2. Garas,F.K.,Clarke,J. Land Armer GST, "Structural assessment", Butterworths,London,1987

REFERENCES:

1. James W. Dally and William Franklin Riley, "Experimental Stress Analysis", McGraw Hill , 3rdEdition,1991
2. Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi,2009.
3. SrinathLS, Raghavan Mr, Lingaiah K, Gargesha G, Pant Band Ramachandra, K, "Experimental Stress Analysis", Tata Mc Graw Hill Company, NewDelhi, 1984
4. Sirohi,R.S.andRadhakrishna,H.C,"MechanicalMeasurements",NewAgeInternational (P) Ltd,3rdEdition1997

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	1	1	-	-	-	-	-	-	2	2
CO2	3	3	2	3	1	1	-	-	-	-	-	-	2	2
CO3	3	3	2	3	1	1	-	-	-	-	-	-	2	2
CO4	3	3	2	3	1	1	-	-	-	-	-	-	2	2
CO5	3	3	2	3	1	1	-	-	-	-	-	-	2	2
Avg.	**3**	**3**	**2**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**

CC24E10	RELIABILITY IN ENGINEERING SYSTEMS	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:
Proficiency in probability theory and statistical methods is crucial for analyzing and modeling reliability data and failure rates.

OBJECTIVES:
The Course will enable learners to:
- The ability to use statistical tools to characterize the reliability of an item
- Understand the failure data analysis.
- The working knowledge to determine the reliability of a system
- To suggest approaches to enhancing system reliability;
- The ability to select appropriate reliability validation methods

UNIT - I	RELIABILITY CONCEPT	9

Reliability definition – Quality and Reliability– Reliability mathematics – Reliability functions – Hazard rate–Measures of Reliability–Design life–Apriori and posteriori probabilities– Mortality of a component–Bath tub curve–Useful life

UNIT - II	FAILURE DATA ANALYSIS	9

Data collection –Empirical methods: Ungrouped/Grouped, Complete/Censored data – Time to failure distributions: Exponential, Weibull– Hazard plotting– Goodness of fittests

UNIT - III	RELIABILITYASSESSMENT	9

Different configurations–Redundancy–m/nsystem–Complexsystems:RBD–Baye'smethod–
Cut and tie sets –Fault Tree Analysis–Stand by system

UNIT - IV	RELIABILITY MONITORING	9

Life testing methods: Failure terminated – Time terminated – Sequential Testing – Reliability growth monitoring–Reliability allocation–Software reliability

UNIT - V	RELIABILITY IMPROVEMENT	9

Analysis of downtime – Repair time distribution – System MTTR – Maintainability prediction – Measures of maintainability–System Availability–Replacement theory.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to:

Course Outcomes	Description	Bloom's Taxonomy Level
CO1	Analyse the interference between strength and stress, or life data for estimating reliability	Analyze
CO2	Apply the appropriate methodologies and tools for enhancing the inherent and actual reliability of components and systems, taking into consideration cost aspects	Apply
CO3	Specify life test plans for reliability validation	Understand
CO4	Get knowledge on reliability monitoring	Understand
CO5	Analyze the downtime for reliability improvement	Analyze

TEXT BOOKS:

1. Charles E.Ebeling, "An introduction to Reliability and Maintain ability engineering", TMH,2000.
2. Roy Billington and Ronald N. Allan, "Reliability Evaluation of Engineering Systems", Springer,2007

REFERENCES:

1. Alessandro Birolini, Reliability Engineering: Theory and Practice 8th ed. 2017 Edition
2. Mohammad Modarres, Mark P. Kaminskiy, Vasiliy Krivtsov "Reliability Engineering and Risk Analysis: A Practical Guide", Third Edition 3rd Edition

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	1	1	-	-	-	-	-	-	2	3
CO2	3	3	2	3	1	1	-	-	-	-	-	-	2	3
CO3	3	3	2	3	1	1	-	-	-	-	-	-	2	3
CO4	3	3	2	3	1	1	-	-	-	-	-	-	2	3
CO5	3	3	2	3	1	1	-	-	-	-	-	-	2	3
Avg.	**3**	**3**	**2**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

CC24E11	LEAN MANUFACTURING	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Lean manufacturing course Familiarity with foundational knowledge in manufacturing processes and basic management machinery, and workflow concepts.

OBJECTIVES:

The Course will enable learners to:

- familiar with the necessity for a Lean Manufacturing system
- distinguish between the conventional Mass production system with Lean system
- Implement the principles of JIT
- Learn the Inspection tools effectively in the Lean systems
- pertain Hoshin planning system to create a Lean culture in Industry

UNIT - I	INTRODUCTION	(9)

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	(9)

Standards in the lean system – 5S system – Total Productive Maintenance – standardized work – Elements of standardized work – Charts to define standardized work – Man power reduction – Overall efficiency - standardized work and Kaizen – Common layouts.

UNIT - III	JUST IN TIME	(9)

Principles of JIT – JIT system – Kanban – Kanban rules – Expanded role of conveyance – Production levelling – Pull systems – Value stream mapping.

UNIT - IV	JIDOKA (AUTOMATION WITH A HUMAN TOUCH)	(9)

Jidoka concept – Poka-Yoke (mistake proofing) systems – Inspection systems and zone control – Types and use of Poka-Yoke systems – Implementation of Jidoka.

UNIT - V	WORKER INVOLVEMENT AND SYSTEMATIC PLANNING METHODOLOGY	(9)

Involvement – Activities to support involvement – Quality circle activity – Kaizen training - Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Phases of Hoshin Planning – Lean culture

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	know the necessity for a Lean Manufacturing system	*Remembering*
CO2	Differentiate between the conventional Mass production system with Lean system	*Analyzing*
CO3	Effectively implement the principles of JIT	*Applying*
CO4	Apply the Inspection tools effectively in the Lean systems	*Applying*
CO5	Apply Hoshin planning system to create a Lean culture in Industry	*Applying*

TEXT BOOKS:

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

REFERENCES:

1. Michael, L.G., “Lean Six SIGMA: Combining Six SIGMA Quality with Lean Production Speed”, McGraw Hill, 2002
2. Ohno, T.,” Toyota Production System: Beyond Large-Scale Production”, Taylor & Francis, Inc., 1988.
3. Rother, M., and Shook, J.,’ Learning to See: Value Stream Mapping to Add Value and Eliminate MUDA”, Lean Enterprise Institute, 1999.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	3	2	1	-	-	-	-	-	2	3
CO2	3	2	2	3	2	1	-	-	-	-	-	2	3
CO3	3	2	2	3	2	1	-	-	-	-	-	2	3
CO4	3	2	2	3	2	1	-	-	-	-	-	2	3
CO5	3	2	2	3	2	1	-	-	-	-	-	2	3
Avg.	**3**	**2**	**2**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

1-low, 2-medium, 3-high

CC24E12	PERFORMANCE MODELING AND ANALYSIS OF MANUFACTURING SYSTEMS	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

Basic understanding of manufacturing processes and systems, including production techniques, equipment, and workflows.

OBJECTIVES:

The Course will enable learners to:

- Develop an understanding of the use and benefits of modeling and simulation in manufacturing systems design and operation.
- Develop an understanding of techniques to assess factory performance and identify areas for improvement.
- Develop an understanding of techniques to assess and manufacturing performance.
- Develop an understanding of techniques to enable responsive manufacturing systems.
- Provide the students with knowledge of a set of tools to enable them to assess the performance of a manufacturing facility

UNIT– I	**MANUFACTURING SYSTEMS & CONTROL**	**9**

Automated Manufacturing Systems- Modelling- Role of performance modelling – simulation models- Analytical models. Product cycle - Manufacturing automation - Economics of scale and scope - input/output model- plant configurations. Performance measures-Manufacturing lead time - Work in process- Machine utilization-Throughput–Capacity-Flexibility- performability - Quality. Control Systems - Control system architecture - Factory communications - Local area networks-Factory networks – Open systems interconnection model – Network to network interconnections – Manufacturing automation protocol – Database management system.

UNIT– II	**MANUFACTURING PROCESSES**	**9**

Examples of stochastic processes – Poisson process Discrete time Markov chain models-Definition and notation-Sojourn times in states-Examples of DTMCs in manufacturing-Chapman-Kolmogorov equation-Steady-state analysis. Continuous Time Markov Chain Models Definitions and notation – Sojourn times in states – examples of CTMCs in manufacturing-Equations for CTMCevolution- Markovmodelofatransferline. Birth and Death Processes in Manufacturing- Steady state analysis of BD Processes-Typical BD processes in manufacturing.

UNIT– III	**QUEUING MODELS**	**9**

Notation for queues - Examples of queues in manufacturing systems - Performance measures - Little's result-Steady state analysis of M/M/m queue, queues with general distributions and queues with breakdowns-Analysis of a flexible machine center

UNIT– IV	**QUEUING NETWORKS**	**9**

Examples of QN models in manufacturing - Little's law in queuing networks - Tandem queue – An open queuing network with feedback- An open central server model for FMS- Closed transfer line- Closed server model-Garden Newell networks.

UNIT– V	**PETRINETS**	**9**

Classical Petri Nets - Definitions - Transition firing and reachability - Representational power - properties-Manufacturing models. Stochastic PetriNets- Exponential timed Petri Nets-Generalized Stochastic Petri Nets-modeling of KANBAN systems-Manufacturing models

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

Course Outcome	Description	Bloom's Taxonomy Level
CO1	Model and simulate the operation of a small manufacturing system	Understand
CO2	Use simulation as a manufacturing system design technique	Understand
CO3	Justify the use of manufacturing modeling and simulation	Apply
CO4	Use techniques such as value stream mapping and IDEF to identify improvements required in a manufacturing system	Apply
CO5	Apply the techniques like Petrinets and KANBAN system in manufacturing system	Apply

TEXT BOOKS:

1	Viswanadham, N and Narahari, Y. "Performance Modeling of Automated Manufacturing Systems", Prentice Hall of India, New Delhi,2005.
2	Law A. W. and Kelton D. W. – 'Simulation Modeling and Analysis' – McGraw Hill – 2010 – 5th Edition
3	Kelton D. W., Sadowski R. P. and Sasowski D. A. – 'Simulation with ARENA' – McGraw Hill – 2009

REFERENCES:

1	Gupta S.C., & Kapoor V. K., "Fundamentals of Mathematical Statistics",3rd Edition, Sultan Chand and Sons, New Delhi,1988.
2	Trivedi, K.S., "Probability and Statistics with Reliability, Queuing and Computer Science Applications", 2016
3	Banks J., Carson J. S., Nelson B. L. and Nicol D. M. – 'Discrete Event System Simulation' – Pearson Education – 2001 – 3rd Edition
4	Viswanathan N. and Narahari Y. – 'Performance Modeling of Automated Manufacturing Systems' – Prentice Hall – 1998
5	Horst Tempelmeier and Heinrich Kuhn "Flexible Manufacturing Systems: Decision Support for Design and Operation" , Springer - 2007

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	1	-	-	-	-	-	-	2	3
CO2	3	3	2	2	1	1	-	-	-	-	-	-	2	3
CO3	3	3	2	2	1	1	-	-	-	-	-	-	2	3
CO4	3	3	2	2	1	1	-	-	-	-	-	-	2	3
CO5	3	3	2	2	1	1	-	-	-	-	-	-	2	3
Avg.	**3**	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

CC24E13	CREATIVITY AND INNOVATION	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:
Basic understanding of design processes and methodologies can be helpful as creativity and innovation often apply to product and process design.

OBJECTIVES:

The Course will enable learners to:

- Apply the basic concepts of design thinking in new product design and development.
- Apply the principles of various methods and tools for creativity in new product design and development.
- Apply the design principles of creativity in new product design and development.
- Apply the various innovation principles and practices in new product design and development.
- Apply the principles of innovation management in new product design and development.

UNIT I	INTRODUCTION TO DESIGN THINKING CONCEPT	9

Design Thinking – Introduction – What- How – Why- Design Process- Four Questions – Ten Tools- Identify an opportunity – Scope your opportunity – Draft your design brief

UNIT II	METHODS AND TOOLS FOR CREATIVITY	9

Three basic principles behind the tools of directed creativity – Tools that prepare the mind for creative thought – Tools that stimulate the imagination for new idea – Development and action: the bridge between mere creativity and the rewards of innovation - ICEDIP: Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation

UNIT III	DESIGN AND APPLICATION OF CREATIVITY	9

Three levels of emotional design: Visceral, Behavioral and Reflective – Process design, reengineering, and creativity – Creativity and customer needs analysis – Innovative product and service design – Creative problem solving and incremental improvement

UNIT IV	INNOVATION PRINCIPLES & PRACTICES	9

Methods of Creativity Activation: Morphological Box – Requirements for Inventive Problem Solving – Altshuller's Engineering Parameters– Altshuller's Inventive Principles– Altshuller's Contradiction Matrix Algorithm.

UNIT V	INNOVATION MANAGEMENT	9

Disruptive Innovation Model – Two Types of Disruption – Three Approaches to Creating New- Growth Businesses – New Market Disruptions: Three Case Histories – Product Architectures and Integration – Process of commoditation and de-commoditation – Two Processes of Strategy Formulation – Role of senior executive in leading new growth: The Disruptive Growth Engine.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

Course Outcome	Description	Bloom's Taxonomy Level
CO1	Understand processes that enhances innovation activities	Understand
CO2	Apply the principles of various methods and tools for creativity in new product design and development.	Apply
CO3	Apply the design principles of creativity in new product design and development.	Apply
CO4	Apply the various innovation principles and practices in new product design and development	Apply
CO5	Apply the principles of innovation management in new product design and development	Apply

TEXT BOOKS:

1	Clayton M. Christensen Michael E. Raynor," The Innovator's Solution", Harvard Business School Press Boston, USA, 2013
2	Donald A. Norman," Emotional Design", Perseus Books Group New York , 2004
3	Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata McGraw Hill, 2004**.**

REFERENCES:

1	Geoffrey Petty," how to be better at Creativity", LULU Enterprises Inc., Raleigh, NC, 2017
2	Rousing Creativity: Think New Now Floyd Hurr, ISBN 1560525479, Crisp Publications Inc. 1999
3	Semyon D. Savransky," Engineering of Creativity – TRIZ", CRC Press New York USA 2003.
4	Vinnie Jauhari, SudanshuBhushan, Innovation Management, Oxford Higher Education, 2014.
5	Innovation Management, C. S. G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	1	1	-	-	-	-	-	-	2	3
CO2	3	3	2	3	1	1	-	-	-	-	-	-	2	3
CO3	3	3	2	3	1	1	-	-	-	-	-	-	2	3
CO4	3	3	2	3	1	1	-	-	-	-	-	-	2	3
CO5	3	3	2	3	1	1	-	-	-	-	-	-	2	3
Avg.	**3**	**3**	**2**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

CC24E14	INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:
Familiarity with automation principles and control systems, including feedback control, sensors, and actuators used in industrial automation.

OBJECTIVES:

The Course will enable learners to:

- Appreciate the need and scope for robotics and to understand the principles of robot kinematics
- Design the drive systems and its control
- Understand the principles of sensors and vision systems
- Envision the industrial applications of robots and its safety
- Gain knowledge on artificial intelligence and expert systems.

UNIT I	INTRODUCTION AND ROBOT KINEMATICS	9

Definition need and scope of Industrial robots– Robot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT II	ROBOT DRIVES AND CONTROL	9

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers

UNIT III	ROBOT SENSORS	9

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

UNIT IV	ROBOT PROGRAMMING, ROBOT CELL DESIGN AND APPLICATION	9

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial application of robots. Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation.

UNIT V	ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS	9

Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques–problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots. Elements of Knowledge Representation -Logic, Production Systems, Semantic Networks, Expert Systems, Components, Applications, Knowledge Building Environment Systems (KBES)-Humanoids.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

Course Outcome	Description	Bloom's Taxonomy Level
CO1	Understand robot kinematics	Understand
CO2	Incorporate mechanical components and concepts in robotics	Apply
CO3	Understand the basics of various sensors to effectively design a robot	Understand
CO4	Design suitable robots for specific applications	Apply
CO5	Optimize the robots using Artificial Intelligence	Analyse

TEXT BOOKS:

1	K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 2004
2	Jordanides,T. and Torby,B.J., ,"Expert Systems and Robotics", Springer –Verlag, New York, 2011
3	Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., "Industrial Robotics Technology, Programming and Applications", McGraw-Hill, Int., 2019

REFERENCES:

1	Klafter,R.D., Chmielewski, T.A. and Negin,M., "Robotics Engineering – An Integrated Approach",Prentice-Hall of India Pvt. Ltd., 2003
2	Deb, S.R."Robotics Technology and Flexible Automation", Tata McGraw-Hill, 2017
3	Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, 1985
4	Koren,Y., "Robotics for Engineers", McGraw-Hill, 1987
5	Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press 3. (2006).

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	1	1	-	-	-	-	-	-	2	3
CO2	3	2	2	3	1	1	-	-	-	-	-	-	2	3
CO3	3	2	2	3	1	1	-	-	-	-	-	-	2	3
CO4	3	2	2	3	1	1	-	-	-	-	-	-	2	3
CO5	3	2	2	3	1	1	-	-	-	-	-	-	2	3
Avg.	**3**	**2**	**2**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

CC24E15	DESIGN FOR CELLULAR MANUFACTURING SYSTEMS	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:
Familiarity with the design and analysis of manufacturing processes, including work cell design and process flow.

OBJECTIVES:

The Course will enable learners to:

- Understand the basic concepts in Cellular manufacturing system
- Understand the planning and design of CMS
- Implement the GT/CMS in Manufacturing system
- Understand the performance and analysis GT/CMS
- Understand the Human and economical aspects of CMS.

UNIT– I	INTRODUCTION	9

Group Technology – Limitations of traditional manufacturing systems – Group machining concept– Principle of cellular manufacturing – Terminology associated with cellular manufacturing –Characteristics and perspectives of cellular manufacturing – Areas of applications of cellular manufacturing – Benefits and limitations of cellular manufacturing

UNIT– II	CMS PLANNING AND DESIGN	9

Types of CMS- Problems in GT/CMS- CMS Evaluation and Selection - Design of CMS - UX Design for CMS - Customization and Integration - Testing and Quality Assurance- Models, traditional approaches and non-traditional approaches -Genetic Algorithms, Simulated Annealing, Neural networks.

UNIT– III	IMPLEMENTATION OF GT/CMS	9

Installation and Setup - Core Configuration - Plugins and Extensions - SEO and Analytics - Deployment and Launch - Post-Launch Maintenance - Inter and Intra cell layout, cost and non-cost based models, establishing a team approach, Managerial structure and groups, batch sequencing and sizing, life cycle issues in GT/CMS.

UNIT– IV	PERFORMANCE MEASUREMENT AND CONTROL	9

Measuring CMS performance - Performance Measurement Techniques - Control Strategies in Manufacturing - Lean Manufacturing and Cellular Systems - Parametric analysis - PBC in GT/CMS, cell loading, Advanced Performance Measurement ,GT and MRP – framework.

UNIT– V	ECONOMICS OF GT/CMS	9

Economic Justification of cellular manufacturing – Economic Principles of GT/CMS - Cost Analysis in GT/CMS - Financial Metrics and Evaluation - Quality Improvement and Economic Impact - Emerging Trends and Future Directions - Use of computer models in GT/CMS – Human aspects of GT/CMS – Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

Course Outcome	Description	Bloom's Taxonomy Level
CO1	Impart knowledge on group technology, optimization algorithms	Understand
CO2	Learn the aspects of cellular manufacturing and its design	Understand
CO3	Know the implementation of GT/CMS	Understand
CO4	Understand Performance measurements of CMS.	Understand
CO5	Understand the economics of GT/CMS	Understand

TEXT BOOKS:

1	Mikell P. Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing" Pearson Education, Fourth Edition, July 2016
2	Technology and Management ", Cleland.D.I. and Bidananda, B (Eds), TAB Books , NY, 1991.
3	Burbidge, J.L. Group "Technology in Engineering Industry ", Mechanical Engineering pub.London, 1979

REFERENCES:

1	Modeling and Analysis of Manufacturing Systems- R. G. Askin, and C. R. Standridge, John Wiley & Sons, 1995
2	Manufacturing Systems Modeling and Analysis- G. L. Curry and R. M. Feldman, Springer,2011
3	Stereolithography and other RP& M Technologies- Paul F. Jacobs, Society of Manufacturing Engineers, NY, 1995
4	Irani, S.A. " Cellular Manufacturing Systems ", John Wiley & Sons, 1999
5	Kamrani, A.K, Parsaei, H.R and Liles, D.H. (Eds), " Planning, design and analysis of cellular manufacturing systems ", Elsevier, 1999

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	1	-	-	-	-	-	-	2	3
CO2	3	3	2	2	1	1	-	-	-	-	-	-	2	3
CO3	3	3	2	2	1	1	-	-	-	-	-	-	2	3
CO4	3	3	2	2	1	1	-	-	-	-	-	-	2	3
CO5	3	3	2	2	1	1	-	-	-	-	-	-	2	3
Avg.	**3**	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

CC24E16	MANUFACTURING TECHNOLOGY FOR ELECTRONIC DEVICES	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:
Familiarity with general manufacturing processes, such as fabrication, assembly, and packaging techniques specific to electronics.

OBJECTIVES:

The Course will enable learners to:

- Impart knowledge on wafer preparation and PCB fabrication
- Introduce Through Hole Technology (THT) and Surface Mount Technology (SMT) with various types of electronic components
- Elaborate various steps in Surface Mount Technology (SMT)
- Be acquainted with various testing and inspection methods of populated PCBS
- Outline repair, rework and quality aspects of Electronic assemblies.

UNIT I — INTRODUCTION TO ELECTRONICS MANUFACTURING — 9

History, definition, wafer preparation by growing, machining, and polishing, diffusion, microlithography, etching and cleaning, Printed Circuit Boards, types- single sided, double sided,

multi layer and flexible printed circuit board, design, materials, manufacturing, inspection. Electronic packaging – Through Hole Technology (THT) and Surface Mount Technology (SMT)

UNIT II — COMPONENTS AND PACKAGING — 9

Through-hole components – axial, radial, multi leaded, odd form. Surface mount components-active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, Flip chip, chip on board, multi chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization and trends

UNIT III — SOLDERING AND CLEANING — 9

Soldering theory, effect of elemental constituents on wetting, microstructure and soldering, solder paste technology – fluxing reactions, flux chemistry, solder powder, solder paste composition and manufacturing, solder paste rheology, Wave soldering. Adhesive and solder paste application. solder system variables. soldering temperature profile. Reflow soldering - profile generation and control, soldering quality and defects. Post solder cleaning and selection. Measurement of cleanliness levels.

UNIT IV — SURFACE MOUNT TECHNOLOGY — 9

SMT Equipment and Material Handling Systems, Handling of Components and Assemblies - Moisture Sensitivity and ESD, Safety and Precautions Needed, IPC and Other Standards, Stencil Printing Process, solder paste storage and handling, stencils and squeegees, process parameters, quality control - Component Placement, Equipment Type, Chip shooter, IC placer, Flexibility, Accuracy of Placement, Throughput, reflow soldering, adhesive, underfill and encapsulation process, applications, storage and handling, process & parameters.

UNIT V — INSPECTION, TEST AND REWORK FOR PCB: — 9

Inspection Techniques, Equipment and Principle – AOI, X-ray. stencil printing process- defects & corrective action, component placement process - defects & corrective action, Reflow Soldering Process- defects & corrective action, underfill and encapsulation Process- defects & corrective action, Testing of assemblies, In-circuit testing (ICT), functional testing, concept of yield, Rework and Repair, tools, rework criteria and process, Design for - Manufacturability, Assembly, Reworkability, Testing, Reliability and Environment

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

Course Outcome	Description	Bloom's Taxonomy Level
CO1	Realize wafer preparation and PCB fabrication	Understand
CO2	Elaborate on through hole and surface mount technology components.	Apply
CO3	Discuss the steps involved in soldering post solder cleaning and its importance in PCB manufacturing	Understand
CO4	Improve knowledge on surface mount technology	Apply
CO5	Locate the required inspections, testing and repair methods used in PCB.	Analyze

TEXT BOOKS:

1	Coombs, Jr. C.E., " Printed Circuits Handbook " Mc Graw-Hill Hand books Sixth Edition, 2008
2	Gurnett, K.W., "Surface Mount Handbook", Newnes Elsevier , 1999
3	Landers, T.L., "Electronics Manufacturing Processes", Prentice Hall, 1998

REFERENCES:

1	Lee, N.C., "Reflow Soldering Process and Trouble Shooting – SMT, BGA, CSP and Flip Chip Technologies", Newnes Elsevier, 2001
2	Prasad R.P., "Surface Mount Technology: Principles and Practice", New York: Chapman and Hall, 2013
3	Seraphim, D., Lasky, R.C. and Che-Yu Li, "Principles of Electronic Packaging" Mcgraw Hill, 1989.
4	Strauss, R.," SMT Soldering Handbook", Newnes Elsevier , 2001
5	Zant, P.V., " Microchip Fabrication – a practical guide to semiconductor processing "McGraw Hill, 2000

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	1	1	-	-	-	-	-	-	2	3
CO2	3	3	2	3	1	1	-	-	-	-	-	-	2	3
CO3	3	3	2	3	1	1	-	-	-	-	-	-	2	3
CO4	3	3	2	3	1	1	-	-	-	-	-	-	2	3
CO5	3	3	2	3	1	1	-	-	-	-	-	-	2	3
Avg.	**3**	**3**	**2**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

CC24E17	SMART MANUFACTURING	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Familiarity with traditional manufacturing methods, machinery, and production workflows to understand the context for smart technologies.

OBJECTIVES:

The Course will enable learners to:

- Understand concepts and basic framework necessary for smart manufacturing
- Gather idea about current trends at system level in manufacturing organizations
- make use of of Sensors and Selection of sensors for various applications
- build the IoT based manufacturing systems
- learn the importance of industry 4.0 concepts at manufacturing systems

UNIT - I	SENSORS SMART MANUFACTURING	(9)

Introduction – Role of sensors in manufacturing automation – operation principles of different sensors – electrical, optical, acoustic, pneumatic, magnetic, electro-optical and vision sensors. Condition monitoring of manufacturing systems – principles – sensors for monitoring force, vibration and noise, selection of sensors and monitoring techniques. Automatic identification techniques for shop floor control – optical character and machine vision sensors – smart / intelligent sensors – integrated sensors, Robot sensors, Micro sensors, Nano sensors.

UNIT - II	DATA ANALYTICS	(9)

Introduction to Data and Analytics in a Digital Context (Internet of Things), Product Data Management for Design and Manufacturing (PLM Tools), Typical data challenges (data quality, enrichment, integration of ERP & PLM data), Preparing data for analytics (techniques to improve data quality, integration - ETL)

Advances in data visualization & related tools-Statistical Techniques for Analytics, Descriptive Statistics Inferential statistics, Regression and ANOVA

UNIT - III	CYBER PHYSICAL SYSTEMS	(9)

Concept of Cyber Physical Systems (CPS) and Cyber Physical Production System (CPPS), System Architecture for implementation of CPPS, Components for CPPS, Communication for CPPS

UNIT - IV	E- MANUFACTURING	(9)

Introduction of Agent based manufacturing- agent based Manufacturing, Cloud Based Manufacturing Information technology-based Supply chain, Concept of agile manufacturing and E-manufacturing

UNIT - V	INDUSTRY 4.0	(9)

Evaluation of industries, Introduction to Industry 4.0, Challenges in industry 4.0, Impact of Industry 4.0, Case studies on industry 4.0, Introduction to Internet of Things (IoT) and its applications, Smart supply chain and Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Appreciate concepts and basic framework necessary for smart manufacturing	*Remembering*
CO2	Illustrate current trends at system level in manufacturing organizations	*Understanding*
CO3	Use of Sensors and Selection of sensors for various applications	*Remembering*
CO4	Construct IoT based manufacturing systems	*Applying*
CO5	Discover the importance of industry 4.0 concepts at manufacturing systems	*Analyzing*

TEXT BOOKS:

1. M. P. Grover “Automation, Production Systems and Computer-Integrated Manufacturing” Pearson Education, 4th Edition, 2016, ISBN: 978-0133499612

2. 2. Bahga and V. Madisetti, Internet of Things, A hands-on approach, Create Space Independent Publishing Platform, 1st edition, 2014, ISBN: 978-0996025515

REFERENCES:

1. S Jeschke, C. Brecher, H. Song, and D. B. Rawat, Industrial Internet of Things: Cyber manufacturing Systems, Springer, 1st edition, 2017, ISBN: 978-3319425580.
2. S. K. Saha, Introduction to Robotics, Tata Mcgraw Hill Education Private Limited, 2nd Edition, ISBN: 978-9332902800
3. M. Skilton and F. Hovsepian, The 4th Industrial Revolution: Responding to the Impact of Artificial Intelligence on Business, Springer Nature, 2017, ISBN: 978-3-319-62479-2

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	3	2	1	-	-	-	-	-	2	3
CO2	3	2	2	3	2	1	-	-	-	-	-	2	3
CO3	3	2	2	3	2	1	-	-	-	-	-	2	3
CO4	3	2	2	3	2	1	-	-	-	-	-	2	3
CO5	3	2	2	3	2	1	-	-	-	-	-	2	3
Avg.	**3**	**2**	**2**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

1-low, 2-medium, 3-high