DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

PERAMBALUR - 621212

REGULATIONS–2023

CHOICE BASED CREDIT SYSTEM

M.E. –CAD/CAM

CURRICULUM & SYLLABI

DEPARTMENT OF MECHANICAL ENGINEERING

(Applicable to students admitted from the Academic year 2023 – 2024 and subsequently under Choice Based Credit System)

Discussed in BOS meeting Dated: 13.04.2023/ Mechanical Ratified & Approved in Academic Council on 02.09.2023

VISION AND MISSION OF THE INSTITUTUION

Vision:

An active and committed centre of advanced learning focused on research and training in the fields of Engineering, Technology and Management to serve the nation better.

Mission:

- To develop eminent scholar with a lifelong follows up of global standards by offering UG, PG and Doctoral Programmes.
- To pursue Professional and Career growth by collaborating mutually beneficial partnership with industries and higher institutes of research.
- To promote sustained research and training with emphasis on human values and leadership qualities.
- To contribute solutions for the need based issues of our society by proper ways and means as dutiful citizen.

DEPARTMENT OF MECHANICAL ENGINEERING

About the Department

The Department of Mechanical Engineering was established in 2005. It is equipped with state-of-the-art workshops, laboratories and computing facilities. The department has highly qualified and experienced faculty members. The faculty members actively engage in research and constantly publish papers in International and National Journals. Guest lectures and industrial visits are periodically arranged for the students to enhance their curriculum. It strives for all round excellence in students, encouraging them in all extra-curricular activities.

Vision:

To develop highly skilled Mechanical Engineers dedicated to serving society

Mission:

M1: To Foster a dynamic learning environment that prepares competent student- research scholars in Mechanical Engineering.

M2: To Build state-of-the-art laboratories to meet technological advancements and transformations.

M3: To Uphold moral and ethical principles among faculty and students.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1	**Academic Excellence** Excel as successful engineers or entrepreneurs.
PEO 2	**Leadership Quality** Become effective leaders, demonstrating professionalism and a commitment to lifelong learning.
PEO 3	**Research skill and Ethics** Handle real-time projects while upholding ethical values.

PROGRAM OUTCOMES (POs)

PO	Graduate Attribute
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles ofmathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation ofdata, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequentresponsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, andneed for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technologicalchange.

PROGRAM SPECIFIC OUT COMES (PSOs)

PSO 1	Apply fundamental and advanced concepts in mechanical engineering across multiple domains, such as materials, design, manufacturing, and thermal engineering, to effectively design, develop, and implement complex products and systems.
PSO 2	Identify, select, and effectively utilize ICT tools commonly employed Mechanical Engineering such as Computer-Aided Design (CAD) software, simulation software, and data analysis tools to create and apply innovative solutions for the betterment of society.

DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE
(AUTONOMOUS), PERAMBALUR – 621 212
M.E. –CAD/CAM
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	P23CCT11	Computer Applications in Design	PCC	3	0	0	3	3
2	P23CCT12	Design for Manufacture, Assembly and Environments	PCC	3	0	0	3	3
3	P23CCT13	Advanced Strength of Materials	PCC	3	0	0	3	3
4	P23CCT14	Computer Aided Tools for Manufacturing	PCC	3	0	0	3	3
5	P23CCT15	Research Methodology	RMC	3	0	0	3	3
6		Professional Elective-I	PEC	3	0	0	3	3
PRACTICAL								
7	P23CCP11	Computer Aided Design Laboratory	PCC	0	0	4	4	2
8	P23CCP12	Simulation and Analysis Laboratory	PCC	0	0	4	4	2
			TOTAL	**18**	**0**	**8**	**26**	**22**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	P23CCT21	Product Lifecycle Management	PCC	3	0	0	3	3
2	P23CCT22	Finite Element Methods in Mechanical Design	PCC	3	1	0	4	4
3	P23CCT23	Additive Manufacturing and Tooling	PCC	3	0	0	3	3
4	P23CCT24	Industry 4.0	PCC	3	0	0	3	3
5		Professional Elective-II	PEC	3	0	0	3	3
6		Professional Elective- III	PEC	3	0	0	3	3
PRACTICAL								
7	P23CCP21	Computer Aided Manufacturing Laboratory	PCC	0	0	4	4	2
8	P23CCP22	Internship	EEC	0	0	4	4	2
			TOTAL	**18**	**1**	**8**	**27**	**23**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	P23CCT31	Advanced Manufacturing Processes	PCC	3	0	0	3	3
2		Professional Elective-IV	PEC	3	0	0	3	3
3		Professional Elective-V	PEC	3	0	0	3	3
PRACTICAL								
3	P23CCP31	Project Phase-I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**15**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1	P23CCP41	Project Phase-II	EEC	0	0	20	20	12
			TOTAL	**0**	**0**	**20**	**20**	**12**

PROFESSIONAL ELECTIVES

SEMESTER I, ELECTIVE I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	P23CCE11	Integrated Product Development	PEC	3	0	0	3	3
2	P23CCE12	Composite Materials and Mechanics	PEC	3	0	0	3	3
3	P23CCE13	Computer Control in Process Planning	PEC	3	0	0	3	3
4	P23CCE14	Design of Hydraulic and Pneumatic Systems	PEC	3	0	0	3	3
5	P23CCE15	Applied Materials Engineering	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	P23CCE21	Optimization Techniques in Design	PEC	3	0	0	3	3
2	P23CCE22	Advanced Machine tool Design	PEC	3	0	0	3	3
3	P23CCE23	Reverse Engineering	PEC	3	0	0	3	3
4	P23CCE24	Artificial Intelligence Systems	PEC	3	0	0	3	3
5	P23CCE25	Supply Chain Management	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	P23CCE31	Optimization Techniques In Design	PEC	3	0	0	3	3
2	P23CCE32	Reliability in Engineering Systems	PEC	3	0	0	3	3
3	P23CCE33	Ergonomics in Manufacturing	PEC	3	0	0	3	3
4	P23CCE34	Mechanical Behaviour of Materials	PEC	3	0	0	3	3
5	P23CCE35	Data Communications in CAD-CAM	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	P23CCE41	Creativity and Innovation	PEC	3	0	0	3	3
2	P23CCE42	Design and Analysis of Experiments	PEC	3	0	0	3	3
3	P23CCE43	Industrial Robotics and Expert systems	PEC	3	0	0	3	3
4	P23CCE44	Electronics Manufacturing Technology	PEC	3	0	0	3	3
5	P23CCE45	Competitive Manufacturing Systems	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	P23CCE51	Design of Hybrid and Electric Vehicles	PEC	3	0	0	3	3
2	P23CCE52	Virtual Manufacturing	PEC	3	0	0	3	3
3	P23CCE53	Quality Concepts in Design	PEC	3	0	0	3	3
4	P23CCE54	Industrial Safety Management	PEC	3	0	0	3	3
5	P23CCE55	Mechanical Vibrations	PEC	3	0	0	3	3

SUMMARY

S. No	Subject Area	Credits of Paper				Credits Total	Percentage %
		I	II	III	IV		
1	Research Course	**3**	**-**	**-**	**-**	**3**	**4.16**
2	Professional Cores	**16**	**15**	**3**	**-**	**34**	**47.22**
3	Professional Electives	**3**	**6**	**6**	**-**	**15**	**20.83**
4	Employability Enhancement Courses	**-**	**2**	**6**	**12**	**20**	**27.77**
Total		**22**	**23**	**15**	**12**	**72**	**100**

P23CCT11 **COMPUTER APPLICATIONS IN DESIGN** **L T P C**
3 0 0 3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand fundamental concepts of computer graphics and its tools in a generic framework.
2. To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
3. To impart the parametric fundamentals to create and manipulate geometric models using NURBS and solids.
4. To provide clear understanding of CAD systems for 3D modeling and viewing.
5. To create strong skills of assembly modelling 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. Output 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: Hermite bicubic 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 modelling.

UNIT IV VISUAL REALISM 9

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

UNIT V ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLE MANAGEMENT 9

Assembly modelling – 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:

At the end of the course the students would be able to

- **CO1 :** Solve 2D and 3D transformations for the basic entities like line and circle.
- **CO2 :** Formulate the basic mathematics fundamental to CAD system.
- **CO3:** Use the different geometric modelling techniques like feature based modelling, surface modelling and solid modelling.
- **CO4:** Create geometric models through animation and transform them into real world systems.
- **CO5:** Know the assembly modelling.
- **CO6:** Understand the CAD standards.

TEXT BOOKS:

1. David F. Rogers, James Alan Adams "Mathematical elements for computer graphics" second edition, Tata McGraw-Hill edition.2003.
2. Donald Hearn and M. Pauline Baker "Computer Graphics", Prentice Hall, Inc., 1992.
3. Foley, Wan Dam, Feiner and Hughes – Computer graphics principles & practices, Pearson Education – 2003.
4. Ibrahim Zeid Mastering CAD/CAM – McGraw Hill, International Edition, 2007.
5. William M Neumann and Robert F.Sproull "Principles of Computer Graphics", McGraw Hill Book Co. Singapore, 1989.

REFERENCE 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.
3. Donald D Hearn and M. Pauline Baker "Computer Graphics C Version", Prentice Hall, Inc., 2nd Edition, 1996.
4. William M Newman and Robert F.Sproull "Principles of Interactive Computer Graphics", McGraw Hill Book Co. 1stEdition, 2001.

P23CCT12	DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To know the concept of design for manufacturing, assembly and environment.
2. To know the computer application in design for manufacturing and assembly.

UNIT I INTRODUCTION 9

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits -Datum features - Tolerance stacks.

UNIT II FACTORS INFLUENCING FOR M DESIGN 9

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice – Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III COMPONENT DESIGN MACHINING CONSIDERATION 9

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machine ability - Design for economy - Design for clamp ability – Design for accessibility - Design for assembly – Product design for manual assembly - Product design for automatic assembly – Robotic assembly.

UNIT IV COMPONENT DESIGN –CASTING CONSIDERATION 9

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design modifying the design - group technology - Computer Applications for DFMA

UNIT V DESIGN FOR THE ENVIRONMENT 9

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Learn the design principles for manufacturability.
CO2 : Understand the factors influencing design.
CO3: Know the design features for machining considerations.
CO4: Learn the casting considerations for component design.
CO5: Understand the design considerations for protecting the environmental objectives.
CO6: Know the recyclability design in the environment.

TEXT BOOKS:

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
3. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
4. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.
5. Fixel, J. Design for the Environment McGraw Hill., 1996.

REFERENCE 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.
3. Donald D Hearn and M. Pauline Baker "Computer Graphics C Version", Prentice Hall, Inc., 2nd Edition, 1996.
4. William M Newman and Robert F.Sproull "Principles of Interactive Computer Graphics", McGraw Hill Book Co. 1stEdition, 2001.

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P23CCT13	ADVANCED STRENGTH OF MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To evaluate the strength of various structural elements internal forces such as compression, tension, shear, bending and torsion.

UNIT I ELASTICITY 9

Stress-Strain relations and general equations of elasticity in Cartesian, Polar and spherical coordinates differential equations of equilibrium-compatibility-boundary conditions- representation of three-dimensional stress of a tension generalized hook's law - St. Venant's principle-plane stress-Airy's stress function.

UNIT II SHEAR CENTER AND UNSYMMETRICAL BENDING 9

Location of shear center for various sections -shear flows. Stresses and deflections in beams subjected to unsymmetrical loading-kern of a section.

UNIT III CURVED FLEXIBLE MEMBERS AND STRESSES IN FLAT PLATES 9

Circumference and radial stresses-deflections-curved beam with restrained ends-closed ring subjected to concentrated load and uniform load-chain links and crane hooks.-Stresses in circular and rectangular plates due to various types of loading and end conditions -buckling of plates.

UNIT IV TORSION OF NON-CIRCULAR SECTIONS 9

Torsion of rectangular cross section - S.Venants theory - elastic membrane analogy- Prandtl's stress function - torsional stress in hollow thin walled tubes.

UNIT V STRESSES DUE TO ROTARY SECTIONS AND CONTACT STRESSES 9

Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds. Methods of computing contact stress-deflection of bodies in point and line contact applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Apply the knowledge to implement and work in elasticity concept.
CO2 : Practice the principles of shear centre for various sections.
CO3: Learn Stresses in circular and rectangular plates.
CO4: Understand torsional stress in hollow thin walled tubes.
CO5: Learn Radial and tangential stresses in solid disc and ring.
CO6: Understand the contact stress-deflection of bodies in point and line contact

TEXT BOOKS:

1. Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill Education (India) Private Limited, 3 edition, February 2010.
2. Seely and Smith, "Advanced Mechanics of Materials", John Wiley International Edn 1952.
3. Rimoahwnko, "Strength of Materials", Van Nostrand.
4. Wang, "Applied Elasticity", McGraw Hill.Cas, "Strength of Materials", Edward Arnold, London 1957.
5. Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Mc-millanpub. Co., 1985.

REFERENCE BOOKS:

1. Mechanics of Materials, William F. Riley, Leroy D. Sturges, and Dan H. Morris, John Wiley & Sons, current edition.
2. Mechanics of Materials – E.P. Popov; Strength of Materials – Timoshenko.
3. Mechanics of Solids & Structures – D,W.A. Rees; Strength of Materials – D. S. Prakash Rao.

P23CCT14	COMPUTER AIDED TOOLS FOR MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. The purpose of this course is to make the students to get familiarized with various computer aided tools that can be implemented in various industrial applications.

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:

At the end of the course the students would be able to

- **CO1 :** Apply the concepts of machining and writing programming for CNC milling and turning and also to operate CNC milling and turning equipment.
- **CO2 :** To get familiarized with computer aided tools for various industrial applications in Process planning.
- **CO3:** Define limits, fits and gauges and know about tolerances, interchangeability, ISO system of limits and fits and to solve its related problems.
- **CO4:** Know computer aided inspection methods.
- **CO5:** Acquire basic knowledge about the main opportunities provided by Reverse Engineering, Software used and its applications.
- **CO6:** Understand data management work related to reverse engineering.

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.
3. Donald R. Honra, "Co-ordinate measurement and reverse Engineering, American Gear Manufacturers Association.

REFERENCE BOOKS:

1. Ibrahim Zeid and R. Sivasubramanian, "CAD/CAM Theory and Practice", Revised First special Indian Edition, Tata Mc Graw Hill Publication, 2007.
2. Ibrahim Zeid and R. Sivasubramanian, "CAD/CAM Theory and Practice", Revised First special Indian Edition, Tata Mc Graw Hill Publication, 2007.
3. Linda Wills, "Reverse Engineering" Kluwer Academic Press, 1996.

P23CCT15	RESEARCH METHODOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To give an overview of the research methodology and explain the technique of defining a research problem
2. To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review
3. To explain the details of sampling designs, measurement and scaling techniques and also different methods of data collections.
4. To explain several parametric tests of hypotheses and Chi-square test.
5. To explain the art of interpretation and the art of writing research reports.

UNIT I INTRODUCTION 9

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India.

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.

UNIT II REVIEWING THE LITERATURE & RESEARCH DESIGN 9

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, Review of the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

UNIT III DESIGN OF SAMPLE SURVEY & DATA COLLECTION 9

Design of Sample Surveys: Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement, Techniques of Developing Measurement Tools, Scaling, Scale Classification Bases, Scaling Techniques, Multidimensional Scaling, Decidingthe Scale.

Data Collection: Introduction, Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

UNIT IV TESTING OF HYPOTHESES 9

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.

Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, and Cautions in Using Chi Square Tests.

UNIT V INTERPRETATION AND REPORT WRITING 9

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : To develop essential research skills.

CO2 : To develop technical writing skills.

CO3: Understand the various methods used to collect the data to research.

CO4: Demonstrate the concepts of engineering research and its methodologies.

CO5: Formulate appropriate research problem and conduct the experiments using systematic methods.

CO6: Write the report with interpretation.

TEXT BOOKS:

1. Kothari, C.R., "Research Methodology –Methods and techniques", New Age Publications, New Delhi, 2009.
2. Panneerselvam, R., "Research Methodology", Prentice-Hall of India, New Delhi, 2004.
3. D. K. Bhattacharyya, "Research Methodology" Excel Books Publications.
4. Taylor, Sinha & Ghoshal, "Research Methodology: A Guide for Researchers in Management and Social Sciences", PHI Publications.

REFERENCE BOOKS:

1. Trochim, "Research Methods: the concise knowledge base-Atomic" Dog Publishing, 2005.
2. Fink A, "Conducting Research Literature Reviews: From the Internet to Paper", Sage Publications, 2009.

P23CCP11	COMPUTER AIDED DESIGN LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modelling software's
2. To gain knowledge on CNC Machine and its working principle.

LIST OF EXPERIMENTS

1. CAD Introduction.
2. Sketcher.
3. Solid modelling –Extrude, Revolve, Sweep, etc and Variational sweep, Loft, etc.
4. Surface modelling –Extrude, Sweep, Trim.etc and Mesh of curves, Free form etc.
5. Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.
6. Assembly-Constraints, Exploded Views, Interference check.
7. Drafting-Layouts, Standard & Sectional Views, Detailing & Plotting.
8. CAD data Exchange formats- IGES, PDES, PARASOLID, DXF and STL.
9. Exercises in Modelling and drafting of Mechanical Components - Assembly using Parametric and feature based Packages like PRO-E / SOLID WORKS/CATIA / NX etc.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	CNC trainer lathe machine with simulation software	1
2.	CNC trainer milling machine with simulation software	1
3.	CNC trainer simulation software (Fanuc OT & OM)	1
4.	Creo/Elements pro (Formerly pro / Engineer) - University plus lab pack - 30 user licence	30
5.	Bench Model CMM	1
6.	Vision & image processing software	2
7.	Data Processing Software	2
8.	A3 Plotter	1
9.	Intel Core i5 Processor Computer	30

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Get familiarized with the computer applications in design and preparing drawings for various Mechanical components

CO2 : Familiarize with Assembly Models of Machine Components using 3D modelling Software's.

CO3: Knowledge on Create and Evaluate technical drawings using Graphical user interface Tools.

P23CCP12	SIMULATION AND ANALYSIS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modeling software's
2. To gain knowledge on CNC Machine and its working principle.

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: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Intel Core i5 Processor Computer	30
2.	Colour Desk Jet Printer	1
3.	Multi body Dynamic Software License Suitable for Mechanism simulation and analysis	15
4.	MATLAB licenses	5

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Solve engineering problems numerically using Computer Aided Finite Element Analysis packages.

CO2 : Analyze the force, stress, deflection in mechanical components.

CO3: Analyze thermal stress and heat transfer in mechanical components.

CO4: Analyze the vibration of mechanical components.

CO5: Analyze the modal, harmonic, transient and spectrum concepts in mechanical components.

CO6: Analyze of non-linear systems.

P23CCT21	PRODUCT LIFECYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand history, concepts and terminology of PLM.
2. To understand functions and features of PLM/PDM
3. To understand different modules offered in commercial PLM/PDM tools.
4. To demonstrate PLM/PDM approaches for industrial applications.
5. To Use PLM/PDM with legacy data bases, CAx & ERP systems.

UNIT I HISTORY, CONCEPTS AND TERMINOLOGY OF 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 Lifecycle 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, Workflow 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 IN APDM/PLM SOFTWARE 9

Case studies based on top few commercial PLM/PDM tools.

UNIT IV ROLE OF PLM IN INDUSTRIES 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/PLM SOFTWARE 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Summarize the history, concepts and terminology of PLM.
CO2 : Know the functions of PLM/PDM.
CO3: Understand the features of PLM/PDM.
CO4: Use different modules offered in commercial PLM/PDM tools.
CO5: Implement PLM/PDM approaches for industrial applications.
CO6: Integrate PLM/PDM with legacy data bases, CAx& ERP systems.

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.
3. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, "Implementing and Integrating Product Data Management and Software Configuration Management", Artech House Publishers, 2003.

REFERENCE BOOKS:

1. John Stark, "Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question", Springer Publisher, 2007.
2. John Stark, "Product Lifecycle Management: 21st Century Paradigm for Product Realisation", Springer Publisher, 2011 (2nd Edition).
3. Michael Grieves, "Product Life Cycle Management", Tata McGraw Hill, 2006.

P23CCT22	FINITE ELEMENT METHODS IN MECHANICAL DESIGN	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn mathematical models for one dimensional problems and their numerical Solutions.
2. To learn two dimensional scalar and vector variable problems to determine field Variables.
3. To learn Iso parametric transformation and numerical integration for evaluation of Element matrices.
4. To study various solution techniques to solve Eigen value problems.
5. To learn solution techniques to solve non-linear problems.

UNIT I FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS 9+3

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+3

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 Axi symmetric Formulation – Principle of virtual work– Element matrices using energy approach

UNIT III ISO-PARAMETRIC FORMULATION 9+3

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+3

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+3

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Develop mathematical models for one dimensional problem and their numerical solutions.
- **CO2 :** Determine field variables for two dimensional scalar and vector variable problems.
- **CO3:** Evaluate the axisymmetric elements.
- **CO4:** Apply Isoparametric transformation and numerical integration for evaluation of element matrices.
- **CO5:** Apply various solution techniques to solve Eigen value problems.
- **CO6:** Formulate solution techniques to solve non-linear problems.

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.

REFERENCE BOOKS:

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", 4 thEdition, Tata McGraw 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.

P23CCT23	ADDITIVE MANUFACTURING AND TOOLING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology and the associated Aerospace, Architecture, Art, Medical and industrial applications

UNIT I INTRODUCTION 9

Need-DevelopmentofAMsystems–AMprocesschain-ImpactofAMonProductDevelopment- Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits- Applications.

UNIT II REVERSE ENGINEERING AND CADMODELING 9

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING 9

Stereo lithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 9

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

UNIT V TOOLING 9

Classification, Soft tooling, Production tooling, Bridge tooling, direct and indirect tooling, Fabrication processes, Applications Case studies automotive, aerospace and electronics industries

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Understand history, concepts and terminology of additive manufacturing.

CO2 : Apply the reverse engineering concepts for design development.

CO3: Understand the liquid based additive manufacturing techniques.

CO4: Know the solid based additive manufacturing techniques.

CO5: Design and develop newer tooling models.

CO6: An Analyze the cases relevant to mass customization and some of the important research challenges associated with AM and its data processing tools

TEXT BOOKS:

1. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
2. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.

REFERENCE BOOKS:

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.
3. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
4. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2011.

P23CCT24	INDUSTRY 4.0	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Understand Industry 4.0
2. Apply iot and iiot for Industry 4.0
3. 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 ENABLING 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 EMPOWERING 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 DRIVING FUTURE-READY ORGANIZATIONS 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 .

UNITV SCOPE OF INDUSTRY 4.0 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:

At the end of the course the students would be able to

CO1 : Use Industry 4.0 for Industrial Applications.

CO2 : Use IoT and IIoT for Industry 4.0.

CO3: Apply smart devices Industrial Applications.

CO4: Design and develop newer tooling models.

CO5: An Analyze the cases relevant to mass customization and some of the important research challenges associated with AM and its data processing tools

CO6: Identify the scope of Industry 4.0.

TEXT BOOKS:

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things.
2. Arsheep Bahga, Internet of Things: A Hands-On Approach.

P23CCP21	COMPUTER AIDED MANUFACTURING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

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

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: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Computers	30
2.	CAM Software for 3 axis machining or more	30
3.	CNC Production type turning or Machining center	1
4.	Video Measuring System	1
5.	Coordinate Measuring Machine	1
6.	Surface Roughness tester	1
7.	5 -axis Robot	1
8.	Programmable Logic Controller with ladder logic programming software	1
9.	RDMBS Package with relevant modules like Inventory Control and MRP	1
10.	3D Printer	1

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Explain the manual CNC part programming for milling and turning machines.

CO2 : Create part programs using CAM packages for milling and turning Machines.

CO3: Appraise dimensional and geometric measurements of machined features using video measuring system and coordinate measuring machine.

CO4: Construct PLC ladder programming and robot programming.

CO5: Relate the concept of printing parts using additive manufacturing and appreciate the application RDBMS in MRP.

P23CCP22	INTERNSHIP	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. It is mandatory that each student will be required to visit industries based on their field of interest and observe the industry functions. They have to spend at least 21 days in the industries.
2. Also, the student has to submit a hard copy of the observations made in the industry, in the form of a report consisting of a title page, introduction, body chapters and a conclusion with references, running to not less than 20 pages; this will be evaluated by the faculty coordinator/guide.
3. For each student, a faculty guide will be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.
4. At the end of semester exam, one internal examiner and one external examiner, appointed by the COE will examine the internship report and presentation done by the students.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : It helps the students to get familiarized with respect to design standards, design calculations and analysis in designing any mechanical component or system.

P23CCT31	ADVANCED MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To analyze and determine material fabrication processes.
2. To use laboratory instrument doing routine metrological measurements
3. To operate regular machine shop equipment such as grinders, drill presses, lathes, milling machines, shapers and etc
4. To recognize engine machine tool requirements and be selective in the choice of tools.
5. To setup and operate machines, index and determine machine speeds, feeds, and depth of cut requirements.
6. To 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 FABRICATION OF MICROELECTRONIC DEVICES 9

Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in microelectronics, 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

- **CO1 :** Analyze and determine material fabrication processes.
- **CO2 :** Use laboratory instrument doing routine metrological measurements
- **CO3:** Operate regular machine shop equipment such as grinders, drill presses, lathes, milling machines, shapers and etc
- **CO4:** Recognize engine machine tool requirements and be selective in the choice of tools.
- **CO5:** Setup and operate machines, index and determine machine speeds, feeds, and depth of cut requirements.
- **CO6:** Identify with numerical control machining and computer programming

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.
3. Bralla, Design for Manufacture handbook, McGrawhill,1999

REFERENCE BOOKS:

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

P23CCP31 **PROJECT PHASE - I**

L	T	P	C
0	0	12	6

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
2. To develop the methodology to solve the identified problem.
3. To train the students in preparing project reports and to face reviews and viva -voce Examination.

TOTAL: 180 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Demonstrate a sound technical knowledge of their selected project topic.
CO2 : Undertake problem identification, formulation and solution.
CO3 : Design and manufacturing engineering solutions to complex problems utilising a Systems approach.
CO4 : The students will have a clear idea of their area of work and they will be in a position to carry out the remaining phase II work in a systematic way.

P23CCP41 **PROJECT PHASE - II**

L	T	P	C
0	0	24	12

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To solve the identified problem based on the formulated methodology.
2. To develop skills to analyze and discuss the test results, and make conclusions.

TOTAL: 360 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Demonstrate a sound technical knowledge of their selected project topic.
CO2 : Undertake problem identification, formulation and solution.
CO3 : Design engineering solutions to complex problems utilising a systems approach.
CO4 : Demonstrate the knowledge, skills and attitudes of a professional engineer to take up any Challenging ‘engineering and find better solutions to it.

P23CCE11	INTEGRATED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To Understand the principles of generic development process; product planning; customer need analysis for new product design and development.
2. To enhance the understanding of setting product specifications and generate, select, screen, and test concepts for new product design and development.
3. To apply the principles of product architecture and the importance of industrial design principles and DFM principles for new product development.
4. To expose the different Prototyping techniques, Design of Experiment principles to develop a robust design and importance to patent a developed new product.
5. 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 DEVELOPMENT ECONOMICS AND MANAGING PROJECTS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Apply the principles of generic development process; product planning; customer need analysis for new product design and development.
- **CO2 :** Set product specifications and generate, select, screen, test concepts for new product design and development.
- **CO3:** Apply the principles of product architecture, industrial design and design for manufacturing principles in new product development.
- **CO4:** Apply the adopt Prototyping techniques
- **CO5:** Design of Experiment principles to develop a robust design and document a new product for patent.
- **CO6:** Understand the Economic Analysis in PLM

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,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book.

REFERENCE BOOKS:

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 Orwin Homewood, 1992.
3. Stuart Pugh, "Total Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, New York, NY, 1991.

P23CCE12	COMPOSITE MATERIALS AND MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Study of different composite materials and finding its mechanical strength.
2. Fabrication of FRP and other composites by different manufacturing methods.
3. Stress analysis of fiber reinforced Laminates for different combinations of plies with Different orientations of the fiber.
4. Calculation of stresses in the lamina of the laminate using different failure theories.
5. Calculation of residual stresses in different types of laminates under thermo-mechanical Load using the Classical Laminate Theory.

UNIT I INTRODUCTION TO COMPOSITE MATERIALS 9

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.

UNIT II MANUFACTURING OF COMPOSITES 9

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 pressingreaction bonding process-infiltration technique, directoxidation-interfaces.

UNIT III LAMINA CONSTITUTIVE EQUATIONS 9

Lamina Constitutive Equations: Lamina Assumptions–Macroscopic Viewpoint.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.

UNIT IV LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES 9

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.

UNIT V THERMO-STRUCURAL ANALYSIS 9

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 different isotropic layers such as electronic packages etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Calculate for mechanical strength of the composite material.
- **CO2 :** Fabricate the FRP and other composites by different manufacturing methods.
- **CO3:** Analyze fiber reinforced Laminates for different combinations of plies with different Orientations of the fibre.
- **CO4:** Evaluate the stresses in the lamina of the laminate using different failure theories
- **CO5:** Analyze thermo-mechanical 39ehaviour and evaluate residual stresses in different types of laminates using the Classical Laminate Theory.
- **CO6:** Utilize the composite materials in various applications.

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.

REFERENCE BOOKS:

1. Hyer MW andScott R White, "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw-Hill, 1998.
2. Issac M Daniel and OriIshai, "Engineering Mechanics of Composite Materials", OxfordUniversityPress-2006, First Indian Edition-2007.
3. MadhujitMukhopadhyay,"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.

P23CCE13	COMPUTER CONTROL IN PROCESS PLANNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To provide the student with an understanding of the importance of process planning role in manufacturing and the application of Computer Aided Process Planning tool in the present manufacturing scenario

UNIT I INTRODUCTION 9

The Place of Process Planning in the Manufacturing cycle - Process Planning and Production Planning – Process Planning and Concurrent Engineering, CAPP, Group Technology.

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, AUTO PLAN and PRO, CPPP.

UNIT V AN INTERGRADED PROCESS PLANNING SYSTEMS 9

Totally integrated process is planning systems - An Overview - Modulus structure - Data Structure, operation –Report Generation, Expert process planning. isotropic layers such as electronic packages etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : To understand the need of process planning in manufacturing.

CO2 : To know handle the computer aided process planning tool.

CO3: To apply the knowledge of Expert systems, Group technology and part representation for various applications.

CO4: To interpret the use of computer aided process panning for CAD/CAM Systems.

CO5: Identify the production families.

CO6: To analyse the computer aided planning systems for various industrial applications.

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.

REFERENCE BOOKS:

1. Nanua Singh,"SystemsApproachtoComputerIntegratedDesignandManufacturing",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.

P23CCE14	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Acquiring fundamental knowledge of hydraulics and pneumatics, and introduction to basic hydraulic components applied in mobile technical systems. The course elaborates principles of hydraulic and pneumatic devices, electro pneumatic components. It gives an overview of control systems associated with hydraulic applications.

UNIT I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS 9

Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics.

UNIT II CONTROL AND REGULATION ELEMENTS 9

Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems.

UNIT III HYDRAULIC CIRCUITS 9

Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits- design and selection of components - safety and emergency mandrels.

UNIT IV PNEUMATIC SYSTEMS AND CIRCUITS 9

Pneumatic fundamentals - control elements, position and pressure sensing - logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods - step counter method - compound circuit design - combinational circuit design.

UNIT V INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS 9

Pneumatic equipments- selection of components - design calculations – application -fault finding - hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Know the hydraulic power generators
CO2 : Use the control valves
CO3: Create the hydraulic circuits
CO4: Create the pneumatic systems and circuits
CO5: Identify the hydraulic and pneumatic equipments
CO6: Know the installation and maintenance of the circuits

TEXT BOOKS:

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education; 7 the edition 2013.
2. Dudleyt, A. Pease and John J. Pippenger, "Basic fluid power", Prentice Hall, 1987.

REFERENCE BOOKS:

1. Andrew Parr, "Hydraulics and Pneumatics: A Technician's and Engineer's Guide", Elsevier, 3rd Revised edition, January 2011.
2. James R. Daines "Fluid Power: Hydraulics and Pneumatics" August 2012.
3. Bolton. W., "Pneumatic and Hydraulic Systems ", Butterworth –Heinemann, 1997.

P23CCE15	APPLIED MATERIALS ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Acquiring fundamental knowledge of applied materials, and introduction to elastic and plastic behaviour of components. The course elaborates principles of applied materials engineering. It gives an overview of fracture behaviour.

UNIT I ELASTIC AND PLASTIC BEHAVIOUR 9

Elasticity in metals and polymers – Mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals – Strengthening mechanisms, work hardening, solid solution strengthening, grain boundary strengthening, poly phase mixture, precipitation, particle, fiber and dispersion strengthening. Effect of temperature, strain and strain rate on plastic 44ehaviours – Super plasticity – Deformation of non-crystalline material

UNIT II FRACTURE BEHAVIOUR 9

Griffith theory, stress intensity factor and fracture toughness – Toughening mechanisms – Ductile, brittle transition in steel – High temperature fracture, creep – Larson-Miller parameter – Deformation and fracture mechanism maps – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law – Effect of surface and metallurgical parameters on fatigue – Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

UNIT III SELECTION OF MATERIALS 9

Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

UNIT IV MODERN METALLIC MATERIALS 9

Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel – Intermetallics, Ni and Ti aluminides – Smart materials, shape memory alloys – Metallic glass – Quasi crystal and nano crystalline materials.

UNITV NON METALLIC MATERIALS 9

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coatings – Structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TiC, TaC, AI2O3, SiC, Si3N4, CBN and diamond – properties, processing and applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Understand the need of elastic and plastic behaviour.
CO2 : Know handle the fracture behaviour.
CO3: Apply the knowledge of selection of materials.
CO4: Interpret the use of modern metallic materials.
CO5: Analyse the non metallic materials for various industrial applications.
CO6: Identify the various types of materials

TEXT BOOKS:

1. Thomas H.Courtney, "Mechanical Behaviour of Materials ", (2nd Edition), McGraw-Hill, 2005.
2. Michael F. Ashby. Materials Selection in Mechanical Design, Third Edition Butterworth-Heiremann, 2005.
3. Flinn, R.A. and Trojan, P.K., Engineering Materials and their Applications ", (4th Edition), Jaico, 1999.
4. George E.Dieter, "Mechanical Metallurgy ", McGraw Hill, 1988.
5. Metals Hand Book, Vol.10, "Failure Analysis and Prevention ", (10th Edition), 1994.

REFERENCE BOOKS:

1. Andrew Parr, “Mechanical Materials: A Technician's and Engineer's Guide”, Elsevier, 3rd Revised edition, January 2011.
2. James R. Daines "Fluid Power: Mechanical Materials " August 2012.
3. Bolton. W., “Mechanical Materials “, Butterworth –Heinemann, 1997.

P23CCE21 MICRO ELECTRO MECHANICAL SYSTEMS DESIGN

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To introduce students to the fundamental principles and concepts of microsystems and microelectronics.
2. To familiarize students with the materials used in microsystems and the fabrication processes involved in manufacturing microelectronic devices and MEMS components.
3. To provide students with a comprehensive understanding of micromechanical phenomena, including static bending of thin plates, mechanical vibrations, thermal stresses, and fracture mechanics in microsystems.
4. To introduce students to various microsystem manufacturing techniques, cleanroom technology, and packaging methods used in the fabrication and assembly of microdevices.
5. To develop students' skills in microsystem design, including process design, mask layout design, mechanical design, and exploring applications of microsystems in various industries.

UNIT I INTRODUCTION 9

Overview - Microsystems and microelectronics - Working principle of Microsystems - micro actuation techniques - microsensors - types - microactuators - types - micropump - micromotors - micro - valves - microgrippers - scaling laws - scaling in geometry - scaling in rigid body dynamics - scaling in electrostatic forces - scaling in electricity - scaling in fluid mechanics - scaling in heat transfer.

UNIT II MATERIALS AND FABRICATION PROCESS 9

Substrates and wafer-single crystal silicon wafer formation-ideal substrates-mechanical properties-silicon compounds - Sio2, SiC, Si3N4 and polycrystalline silicon - Silicon piezo resistors - Gallium arsenide, Quartz-piezoelectric crystals-polymers for MEMS -conductive polymers – Photolithography - Ion implantation - Diffusion – Oxidation –CVD - Physical vapor deposition - Deposition by epitaxy - etching process

UNIT III MICROMECHANICS 9

Introduction-static bending of thin plates-circular plates with edge fixed - rectangular plate with all edges fixed and square plate with all edges fixed – Mechanical vibration-resonant vibration- micro accelerometers-design theory and damping coefficients- thermo mechanics-thermal stresses-fracture mechanics-stress intensity factors, fracture toughness and interfacial fracture mechanics.

UNIT IV MICRO SYSTEM MANUFACTURING 9

Clean room technology-Bulk Micro manufacturing- surface micro machining –LIGA-SLIGA-Micro system packaging-materials-die level-device level-system level-packaging techniques-die preparation-surface bonding-wire bonding-sealing

UNIT V MICRO SYSTEM DESIGN 9

Design considerations-process design-mask layout design- mechanical design-applications of micro system in -automotive industry-bio medical –aerospace-telecommunications.

Total Hours: 45

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : To understand the working principles of micro systems and microelectronics.

CO2 : Explain the properties of different materials used in micro systems, including silicon compounds, piezoelectric crystals, and polymers.

CO3: Explain the Photolithography, Ion implantation, Diffusion and Oxidation

CO4: To analyze and solve problems related to static bending of thin plates and mechanical vibration in micro systems.

CO5: To familiar with different manufacturing techniques like surface micro machining and LIGA/SLIGA processes.

CO6: To design micro systems using appropriate process design techniques and create mask layout designs for micro fabrication.

TEXT BOOKS:

1. Mohamed Gad-el-Hak, The MEMS Hand book, CRC press 2002.
2. Julian W.Gardner,VijayK.Varadan,OsamaO.AwadelKarim, Micro sensors MEMS and Smart Devices, John Wiby& sons Ltd.,2001.

REFERENCE BOOKS:

1. Fatikow, S. Rembold, U."Microsystem Technology and Microrobotics",Springer, December 2010.
2. Tai-Ran Hsu, MEMS & Microsystems Design and Manufacture,Tata McGraw-Hill, 2006. Francis E.H Tay and W.O Choong, Microfludics and BioMEMS Applications, Springer, 2002.

P23CCE22	ADVANCED MACHINE TOOL DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Selecting the different machine tool mechanisms.
2. Designing the Multi speed Gear Box and feed drives.
3. Designing the machine tool structures.
4. Designing the guide ways and power screws.
5. 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 Guide ways, Design of Guide ways, Design of Aerostatic Slide ways, Design of Anti-Friction Guide ways, Combination Guide ways, 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:

At the end of the course the students would be able to

CO1 : Select the different machine tool mechanisms.
CO2 : Design the Multi speed Gear Box and feed drives.
CO3: Design the machine tool structures.
CO4: Design the guide ways and power screws.
CO5: Design the spindles and bearings.
CO6: Understand the various machine tools

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.

REFERENCE BOOKS:

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.

P23CCE23	REVERSE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Applying the fundamental concepts and principles of reverse engineering in product Design and development.
2. Applying the concept and principles material characteristics, part durability and life Limitation in reverse engineering of product design and development.
3. Applying the concept and principles of material identification and process Verification in reverse engineering of product design and development.
4. Applying the concept and principles of data processing, part performance and System compatibility in reverse engineering of product design and development.
5. 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:

At the end of the course the students would be able to

- **CO1 :** Apply the fundamental concepts and principles of reverse engineering in product Design and development.
- **CO2 :** Apply the concept and principles material characteristics, part durability and life Limitation in reverse engineering of product design and development.
- **CO3:** Apply the concept and principles of material identification and process verification in Reverse engineering of product design and development.
- **CO4:** Apply the concept and principles of data processing, part performance and system Compatibility in reverse engineering of product design and development.
- **CO5:** Analyze the various legal aspect and applications of reverse engineering in product design and development.
- **CO6:** Apply reverse engineering in the automotive industry.

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.

REFERENCE BOOKS:

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.

P23CCE24	ARTIFICIAL INTELLIGENCE SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. The course aims at providing the basic concepts of machine intelligence, knowledge representation and languages used in AI so that student can have a basic knowledge in AI.

UNIT I SCOPE OF ARTIFICIAL INTELLIGENCE 9

Games, theorem proving, natural language processing, vision and speech processing, robotics, expert systems, Artificial Intelligent techniques- search knowledge, abstraction.

UNIT II PROBLEM SOLVING 9

State space search, Production systems, search space control, depth-first, breadth-first search, heuristic search – Hill climbing, best-first search, branch and bound, Problem Reduction, Constraint Satisfaction End, Means-End Analysis.

UNIT III KNOWLEDGE REPRESENTATION 9

Predicate Logic – Unification, modus pones, resolution, dependency directed backtracking, Rule based Systems, Forward reasoning, conflict resolution, backward Reasoning, use of no backtrack, Structured Knowledge Representation, Semantic Nets, slots, exceptions and default frames, conceptual dependency, scripts.

UNIT IV HANDLING UNCERTAINTY AND LEARNING 9

Non-Monotonic Reasoning, Probabilistic reasoning, use of certainty factors, fuzzy logic, Concept of learning, learning automation, genetic algorithm, learning by inductions, neural nets.

UNIT V EXPERT SYSTEMS 9

Need and justification for expert systems, knowledge acquisition, Introduction to machine learning, Intelligence for manufacturing tools, manufacturing brain, eye and hand. Trends in robot intelligence. Case studies in the application of Artificial Intelligence in manufacturing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Understand basic concepts of human and machine intelligence as well as neural networking.
- **CO2 :** Generate fuzzy logic, semantic nets and automated learning.
- **CO3:** Describe the languages used in AI and develop the design of expert system.
- **CO4:** Know the expert system tools and learning, object oriented programming and object oriented expert system.
- **CO5:** Explain the Robotic vision systems, image processing techniques.
- **CO6:** Compare the expert systems.

TEXT BOOKS:

1. Elaine Rich and Kevin Knight “Artificial intelligence”, McGraw Hill Education (India) Private Limited; 3 edition, October 2008.
2. Nilsson N.J., “Principles of Artificial Intelligent”, Morgan Kaufmann Publishers, Inc.; 1 edition, April, 1998).
3. Patterson D. "Introduction to Artificial Intelligence and Expert Systems", PHI, 1997.

REFERENCE BOOKS:

1. Stuart Russell "Artifical Intelligence: A Modern Approach: A Modern Approach" Pearson; Third edition, 2013.
2. Peter Jackson, “Introduction to Expert Systems”, Addison-Wesley; December, 1998.
3. Schalkoff R.J., “Artificial Intelligence - an Engineering Approach”, McGraw Hill Int. Ed., Singapore, 1992.
4. Schalkoff R.J., “Artificial Intelligence - an Engineering Approach”, McGraw Hill Int. Ed., Singapore, 1992.

P23CCE25	SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To impart knowledge on supply chain models and organizational transformations.
2. To improve the overall organization performance and customer satisfaction by improving product or service delivery to consumer.

UNIT I INTRODUCTION **9**

Logistics- concepts, definitions, approaches, factors affecting logistics. Supply chain - basic tasks of the supply chain - the new corporate model.

UNIT II SUPPLY CHAIN MANAGEMENT AND INVENTORY **9**

The new paradigm, the modular company, the network relations, supply process, procurement process - Distribution management, Role of cycle inventory & safety stock in supply chain, Inventory replenishment policies.

UNIT III EVOLUTION OF SUPPLY CHAIN MODELS **9**

Strategy and structure - factors of supply chain - Manufacturing strategy stages, supply chain progress - model for competing through supply chain management - supply chain redesign - Linking supply chain with customer.

UNIT IV SUPPLY CHAIN ACTIVITY SYSTEMS **9**

Structuring the supply chain, new products, functional roles, supply chain design framework - Collaborative product commerce.

UNIT V SUPPLY CHAIN MANAGEMENT ORGANIZATION AND INFORMATION SYSTEM **9**

The management task, logistics organization, the logistics information systems- topology of supply chain application- Resource planning, Enterprise Resource planning, Warehouse management system, product data management- cases.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Understand key theories of supply chain management and logistics in Contemporary organizations.

CO2 : Know the initiative and judgment in planning, problem solving, and decision Making in supply chain management.

CO3: Distinguish theories; models to interpret transmit responses to Sometimes complex supply chain management problems.

CO4: Understand the supply chain design, its system and activities.

CO5: Learn the supply chain management information system.

CO6: Understand the supply chain management organization

TEXT BOOKS:

1. S.Chopra, and P. Meindl, "Supply chain Management: Strategy, Planning and Operations", Sixth Edition, Prentice Hall, 2015.
2. M.Christopher., "Logistics Supply Chain Management –Strategies for Reducing Cost and Improving Service", FT Press, Fourth Edition, 2011.

REFERENCE BOOKS:

1. G.Srinivasan, "Quantitative models in operations and supply chain Management", PHI learning pvt. Ltd-New Delhi, 2010.
2. D.K.Agarwal, "A text book of logistics and supply chain management", Macmillan, 2009.
3. Simchi-Levi, D. Kaminsky, P. Simchi-Levi, E. and Ravi Shankar, "Designing & Managing the Supply Chain: Concepts, Strategies & Case Studies", Third Edition, Tata McGraw-Hill, 2007.

P23CCE31	OPTIMIZATION TECHNIQUES IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand the basic concepts of unconstrained optimization techniques.
2. To understand the basic concepts of constrained optimization techniques.
3. To provide the mathematical foundation of artificial neural networks and swarm Intelligence for design problems.
4. To implement optimization approaches and to select appropriates solution for design Application.
5. 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 behaviours, 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, vibration absorbers. Application in Mechanisms–Optimum design of simple linkage mechanisms.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Formulate unconstrained optimization techniques in engineering design application.
CO2 : Formulate constrained optimization techniques for various applications.
CO3: Implement neural network technique to real world design problems.
CO4: Apply genetic algorithms to combinatorial optimization problems.
CO5: Evaluate solutions by various optimization approaches for a design problem.
CO6: Know the static and dynamic applications.

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,

REFERENCE BOOKS:

1. JohnsonRay, C., “Optimum design of mechanical elements”, Wiley, 2nd Edition1980.
2. Kalyanmoy Deb, “Optimization for Engineering Design: Algorithms and Examples”, PHI LearningPri vate Limited, 2nd Edition, 2012.
3. Rao Singiresu S., “Engineering Optimization – Theory and Practice”, New Age International Limited, New Delhi, 3rdEdition, 2013.
4. Rajasekaran S and Vijayalakshmi Pai, G.A, "Neural Networks, Fuzzy Logic And Genetic Algorithms",PHI,2011

P23CCE32	RELIABILITY IN ENGINEERING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. The ability to use statistical tools to characterize the reliability of an item;
2. The working knowledge to determine the reliability of a system.
3. To suggest approaches to enhancing system reliability;
4. The ability to select appropriate reliability validation methods.

UNIT I RELIABILITY CONCEPT 9

Reliability definition – Quality and Reliability– Reliability mathematics – Reliability functions – Hazardrate–MeasuresofReliability–Designlife–Aprioriandposterioriprobabilities– Mortalityofacomponent–Bathtubcurve–Usefullife.

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 fit tests.

UNIT III RELIABILITYASSESSMENT 9

Different configurations–Redundancy–m/n system–Complex systems: RBD–Baye's method– Cutandtiesets–Fault Tree Analysis–Stand by system.

UNIT IV RELIABILITY MONITORING 9

Life testing methods: Failure terminated – Time terminated – Sequential Testing – Reliabilitygrowthmonitoring–Reliabilityallocation–Softwarereliability.

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:

At the end of the course the students would be able to

- **CO1 :** Analyse the interference between strength and stress, or life data for estimating reliability;
- **CO2 :** Apply the appropriate methodologies and tools for enhancing the inherent and actual reliability of components and systems, taking into consideration cost aspects; specify life test plans for reliability validation
- **CO3:** Utilize techniques such as RBD, Bayesian methods, and Fault Tree Analysis.
- **CO4:** Analyze downtime, repair time, maintainability, system availability, and replacement theory.
- **CO5:** Predict maintainability and explore measures of maintainability.
- **CO6:** Calculate system availability and delve into replacement theory for reliability improvement.

TEXT BOOKS:

1. CharlesE.Ebeling,"AnintroductiontoReliabilityandMaintainabilityengineering",TMH,2000.

REFERENCE BOOKS:

1. Dan Petersen, "Techniques of Safety Management", McGraw-Hill Company, Tokyo, 1981.
2. Roy Billington and Ronald N. Allan, "Reliability Evaluation of Engineering Systems", Springer, 2007.
3. Alessandro Birolini, Reliability Engineering: Theory and Practice 8th ed. 2017 Edition
4. Mohammad Modarres, Mark P. Kaminskiy, Vasiliy Krivtsov "Reliability Engineering and Risk Analysis: A Practical Guide", Third Edition 3rd Edition.

P23CCE33 **ERGONOMICS IN MANUFACTURING**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To increase awareness of the need for and role of ergonomics in occupational health.
2. To obtain knowledge in the application of ergonomic principles to design of industrial workplaces and the prevention of occupational injuries
3. To understand the breadth and scope of occupational ergonomics

UNIT I INTRODUCTION **9**

Interdisciplinary nature of ergonomics, modern ergonomics.

UNIT II HUMAN PERFORMANCE **9**

Information input and processing, factors affecting human performance, physical work load and energy expenditure, heat stress, manual lifting.

UNIT III WORK SPACE DESIGN **9**

Anthropometry, Work-space design for standing and seated workers, arrangement of components within a physical space, interpersonal aspect of workplace design.

UNIT IV DESIGN OF EQUIPMENT **9**

Ergonomic factors to be considered, design of displays and controls, design for maintainability.

UNIT V DESIGN OF ENVIRONMENT **9**

Illumination – Climate – Noise – Motion.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Define ergonomics and its principles.
- **CO2 :** Understand the "physiology" of their body and how types of movements can cause ergonomic problems related to tools/task/workplace.
- **CO3 :** Know how to create "pragmatic" solutions for the design of tools, workplace and tasks using ergonomics knowledge.
- **CO4 :** Describe the essential elements for an effective ergonomics in industry for effective and efficient use of facilities with low risk of WMSDs.
- **CO5 :** Identify and consider key ergonomic factors in the design of displays and controls.
- **CO6 :** Analyze the role of illumination in ergonomics and its impact on the work environment.

TEXT BOOKS:

1. Human Factors in Engg. & Design by Mark S. Sanders & E. J. McCormick, McGraw Hills.
2. Introduction to Ergonomics, R. S. Bridger.

REFERENCE BOOKS:

1. Martin Helander, “A Guide to Ergonomics of Manufacturing”, CRC Press, 2 edition, December 2005.
2. Bridger, R.S., “Introduction to Ergonomics, CRC Press, 3 edition, August 2008.
3. McCormick, J., “Human Factors in Engineering and Design”, McGraw-Hill, 7 edition, January 1993.

P23CCE34	MECHANICAL BEHAVIOR OF MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To know the mechanical behaviour of both metallic and non-metallic materials under different loading and temperature conditions.

UNIT I BASIC CONCEPTS OF MATERIAL BEHAVIOR 9

Elasticity in metals and polymers– Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity –. Griffith's theory, – Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps.

UNIT II BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES 9

Stress intensity factor and fracture toughness – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law.- Safe life, Stress-life, strain-life and fail - safe design approaches -Effect of surface and metallurgical parameters on fatigue – Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

UNIT III SELECTION OF MATERIALS 9

Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection.

UNIT IV MODERN METALLIC MATERIALS 9

Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

UNIT V NON METALLIC MATERIALS 9

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al2O3, SiC, Si3N4 CBN and diamond – properties, processing and applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Recall and describe the concepts of elasticity, strengthening mechanisms, and their effects on material behavior.
- **CO2 :** Evaluate the influence of surface and metallurgical parameters on fatigue behavior.
- **CO3 :** : Explain the relationship between materials selection, processing, and mechanical properties.
- **CO4 :** Analyze case studies in materials selection for various applications, including aerospace, automotive, marine, machinery, and nuclear.
- **CO5 :** Explain the properties and applications of shape memory alloys, metallic glass, and nanocrystalline materials.
- **CO6 :** Apply knowledge of the structure, properties, and applications of engineering polymers.

TEXT BOOKS:

1. Ashby M.F., materials selection in Mechanical Design 2nd Edition, Butter worth 1999.
2. Thomas H. Courtney, Mechanical Behaviour of Materials, (2nd edition), McGraw Hill, 2000

REFERENCE BOOKS:

1. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials, (34 d editions), Butterworth-Heiremann, 1997.
2. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition). Jaico, 1999.
3. Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999.

P23CCE35	DATA COMMUNICATIONS IN CAD/CAM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To enable seamless exchange of data between any two points in the world. This exchange of data takes place over a computer network. Data refers to the raw facts that are collected while information refers to processed data that enables us to take decisions.

UNIT I DIGITAL COMPUTERS & MICRO PROCESSORS 9

Block diagram, Register transfer language, Arithmetic, logic and shift micro operations , Instruction code, Training and control instruction cycle , I/O and interrupt design of basic computer, Machine language, Assembly language, Assembler. Registers ALU and Bus Systems, Timing and control signals, Machine cycle and timing diagram , Functional block diagrams of 80 x 86 and modes of operation , Features of Pentium Processors.

UNIT II OPERATING SYSTEM & ENVIRONMENTS 9

Types, Functions, UNIX & WINDOWS NT, Architecture, Graphical User Interfaces, Compilers, Analysis of the Source program , The phases of a compiler, Cousins of the compiler, The grouping of phases, Compiler construction tools.

UNIT III COMMUNICATION MODEL 9

Data communication and networking, Protocols and architecture, Data transmission concepts and terminology, Guided transmission media, Wireless transmission, Data encoding, Asynchronous and synchronous communication, Base band interface standards RS232C, RS449 interface.

UNIT IV COMPUTER NETWORKS 9

Network structure, Network architecture, The OSI reference model services , Network standardization, Example, Managing remote systems in network , Network file systems, Net working in manufacturing.

UNITV INTERNET 9

Internet services, Protocols, Intranet information services, Mail based service system and network requirements, Internet tools, Usenet, E-mail , IRC, WWW, FTP, Telnet.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Explain the concept of communication between machine and computer.
CO2 : Explain the concept of microprocessors.
CO3 : Discuss the types and functions of operating systems.
CO4 : Understand and explain communication model.
CO5 : Discuss network structure and architecture.
CO6: Understand and discuss internet services.

TEXT BOOKS:

1. Morris Mano. M., "Computer System Architecture", Prentice Hall of India, 1996.
2. Peterson J.L., Galvin P. and Silberschaz, A., "Operating System s Concepts", Addison Wesley, 1997.

REFERENCE BOOKS:

1. William Stallings, "Data of Computer Communications" Prentice Hall of India, 1997.
2. Andrew S. Tanenbanum "Computer Networks", Prentice Hall of India 3rd Edition, 1996.
3. Christian Crumlish, "The ABC's of the Internet", BPB P ublication, 1996.
4. Gaonkar R.S., "Microprocessor Architecture, Programming and Applications of 8085", Penram International, 1997.

P23CCE41	CREATIVITY AND INNOVATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Applying the principles of essential theory of creativity in new product design and development.
2. Applying the principles of various methods and tools for creativity in new product design and development.
3. Applying the design principles of creativity in new product design and development.
4. Applying the various innovation principles and practices in new product design and development.
5. Applying the principles of innovation management in new product design and development.

UNIT I INTRODUCTION TO ESSENTIAL THEORY OF CREATIVITY 9

Directed creativity: The Need for Creative Thinking in the Pursuit of Quality –Essential Theory for Directed Creativity: Definitions and the Theory of the Mechanics of Mind; Heuristics and Models: Attitudes, Approaches, and Actions That Support Creative Thinking.

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, Behavioural 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.

UNITV 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:

At the end of the course the students would be able to

CO1 : Apply the principles of essential theory of creativity in new product design and development.

CO2 : Apply the principles of various methods and tools for creativity in new product design and development.

CO3 : Apply the design principles of creativity in new product design and development.

CO4 : Apply the various innovation principles and practices in new product design and development.

CO5 : Apply the principles of innovation management in new product design and Development.

CO6: Know the various management techniques.

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.

REFERENCE BOOKS:

1. Geoffrey Petty," how to be better at Creativity", The Industrial Society 1999.
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.

P23CCE42	DESIGN AND ANALYSIS OF EXPERIMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To establish optimal process performance by finding the right settings for key process input variables and also to intelligently form frameworks to decide which course of action you might take.

UNIT I SIMPLE COMPARATIVE EXPERIMENTS 9

Strategy of experimentation, applications of experimental design, using statistical design in experimentation. Basic statistical concepts, Sampling and sampling Distribution, Inferences about the Differences in means, randomized designs, Inferences about the Differences in means, Paired comparison Designs, Inferences about the Variances of Normal Distributions.

UNIT II FACTORIAL DESIGN 9

Basic definition and principles, Advantages of factorials, two factor factorial design, General factorial design, Fitting response curves and surfaces, Blocking in a factorial design.

UNIT III FITTING REGRESSION MODELS 9

Introduction, Linear regression models, Estimate of parameters in linear regression models, Hypothesis testing in multiple regression, Confidence intervals in multiple regression, Prediction of new response observations, Regression model diagnostics, Testing for lack of fit.

UNIT IV TAGUCHI METHOD OF DESIGN OF EXPERIMENTS 9

Concept design, Parameter design, Tolerance design, Quality loss function, Signal-to- Noise ratio, Orthogonal array experiments, Analysis of Mean(ANOM), Quality characteristics, Selection and testing of noise factors, Selection of control factors, Parameter optimization experiment, Parameter design case study.

UNITV ANALYSIS OF VARIANCE (ANOVA) 9

Introduction, Example of ANOVA process, Degrees of freedom, Error variance and pooling, Error variance and application, Error variance and utilizing empty columns, the F-test.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Understand statistical tools using experimental design concepts.
CO2 : Gain Knowledge about factorial design using experimentation.
CO3 : Apply regression techniques for experimental analysis.
CO4 : Use taguchi concept for design of experiments.
CO5 : Apply the concept of ANOVA for various processes.
CO6: Utilize the various design and analysis concepts.

TEXT BOOKS:

1. Douglas C Montgomery, "Design and Analysis of Experiments", Wiley" Eighth edition' February 2013.
2. George E. P. Box, J. Stuart Hunter, William G. Hunter Statistical Design and Analysis of Experiments, Wiley-Interscience; 2nd edition, 2005.

REFERENCE BOOKS:

1. MontgomeryD.C., Runger G. C., Introduction to Linear Regression Analysis, Wiley India Pvt Ltd, 3rd edition, December 2006.
2. Raymond H. Myers, Douglas C. Montgomery, Christine M. Anderson-Cook, "Response Surface Methodology: Process Ang Product Optimization Using Designed Experiments, Myres R.H., Montgomery D. C., Wiley-Blackwell; 4th Edition, February 2016.
3. Taguchi,G., "Introduction to Quality Engineering", Asian Productivity Organization, UNIPUB, White Plains, New York, 1986.

P23CCE43	INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To appreciate the need and scope for robotics and to understand the principles of robot kinematics.
2. To design the drive systems and its control.
3. To understand the principles of sensors and vision systems.
4. To envision the industrial applications of robots and its safety.
5. To 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 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.

UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS **9**

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. 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.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Understand robot kinematics.
CO2 : Incorporate mechanical components and concepts in robotics.
CO3 : Understand the basics of various sensors to effectively design a robot.
CO4 : Design suitable robots for specific applications.
CO5 : Optimize the robots using Artificial Intelligence.
CO6: Know the applications of robotics system.

TEXT BOOKS:

1. K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
2. Koren,Y., "Robotics for Engineers", McGraw-Hill, 1987.
3. Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, 1985.

REFERENCE BOOKS:

1. Klafter,R.D., Chmielewski, T.A. and Negin,M., "Robotics Engineering – An Integrated Approach",Prentice-Hall of India Pvt. Ltd., 1984.
2. Deb, S.R."Robotics Technology and Flexible Automation", Tata McGraw-Hill, 1994.
3. Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., "Industrial Robotics Technology, Programming and Applications", McGraw-Hill, Int., 1986.
4. Jordanides,T. and Torby,B.J., ,"Expert Systems and Robotics", Springer –Verlag, New York, May 1991.

P23CCE44	ELECTRONICS MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To impart knowledge on wafer preparation and PCB fabrication.
2. To introduce Through Hole Technology (THT) and Surface Mount Technology (SMT) with various types of electronic components.
3. To elaborate various steps in Surface Mount Technology (SMT).
4. To be acquainted with various testing and inspection methods of populated PCBS.
5. To 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 componentsactive, 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:

At the end of the course the students would be able to

CO1 : Realize wafer preparation and PCB fabrication.
CO2 : Elaborate on through hole and surface mount technology components.
CO3 : Discuss the steps involved in soldering post solder cleaning and its importance in PCB.
CO4 : Improve knowledge on surface mount technology.
CO5 : Locate the required inspections, testing and repair methods used in PCB.
CO6: Choose the electronics manufacturing.

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.

REFERENCE BOOKS:

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, 1997.
3. Seraphim, D., Lasky, R.C. and Che-Yu Li, "Principles of Electronic Packaging" Mcgraw Hill, 1989.
4. Zant, P.V., "Microchip Fabrication – a practical guide to semiconductor processing"McGraw Hill, 2000.

P23CCE45	COMPETITIVE MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To emphasize the knowledge on the quality improvement, automation, and advanced manufacturing techniques to create the highest-caliber products quickly, efficiently, inexpensively, and in synchronization with the marketing, sales, and customer service of the company.

UNIT I MANUFACTURING IN ACOMPETITIVE ENVIRONMENT 9

Automation of manufacturing process – Numerical control – Adaptive control – material handling and movement – Industrial robots – Sensor technology – flexible fixtures – Design for assembly, disassembly and service.

UNIT II GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS 9

Part families – classification and coding – Production flow analysis – Machine cell design – Benefits. Components of FMS – Application work stations – Computer control and functions – Planning, scheduling and control of FMS – Scheduling – Knowledge based scheduling – Hierarchy of computer control – Supervisory computer.

UNIT III COMPUTER SOFTWARE, SIMULATION AND DATABASE OFF MS 9

System issues – Types of software – specification and selection – Trends – Application of simulation – software – Manufacturing data systems – data flow – CAD/CAM considerations – Planning FMS database.

UNIT IV LEAN MANUFACTURING 9

Origin of lean production system – Customer focus – Muda (waste) – Standards – 5S system – Total Productive Maintenance – standardized work –Man power reduction – Overall efficiency – Kaizen – Common layouts – Principles of JIT – Jidoka concept – Poka-Yoke (mistake proofing) – Worker Involvement– Quality circle activity – Kaizen training – Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Lean culture. • To impart knowledge on the pace of changes in the manufacturing technology

UNITV JUST IN TIME 9

Characteristics of JIT – Pull method – quality –small lot sizes – work station loads – close supplier ties – flexible work force – line flow strategy – preventive maintenance – Kanban system – strategic implications – implementation issues – Lean manufacture.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Apply the knowledge to implement and work in competitive manufacturing systems.
- **CO2 :** Practice the principles of flexible manufacturing and Group Technology.
- **CO3:** Learn computer software and its types regarding simulation and data base of FMS.
- **CO4:** Understand Lean Manufacturing concepts and its culture.
- **CO5:** Knowledge on the pace of changes in the manufacturing technology.
- **CO6:** Learn characteristics of Just in Time.

TEXT BOOKS:

1. Jha, N.K., "Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.
2. Bhat, S. K., "Total Quality Management", Himalaya Publishing House Pvt. Ltd., 2011.

REFERENCE BOOKS:

1. Groover, M.P., "Automation, Production Systems and Computer Integrated Manufacturing ", Third Edition, Prentice-Hall, 2007.
2. Kalpakjian, "Manufacturing Engineering and Technology ", AddisonWesley Publishing Co., 1995. 5. Ohno, T.T., "Production System Beyond Large-Scale production", Productivity Press (India) Pvt. Ltd. 1992.
3. Dennis, P., "Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System", (Second edition), Productivity Press, New York, 2007.

P23CCE51	DESIGN OF HYBRID AND ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Fundamental concepts of electric and hybrid vehicle operation and architectures.
2. Understand the properties of batteries and its types.
3. Provide knowledge about design of series hybrid electric vehicles.
4. Provide knowledge about design of parallel hybrid electric vehicles.
5. Understand of electric vehicle drive train.

UNIT I INTRODUCTION TO ELECTRIC VEHICLES 9

Electric Vehicles (EV) system- EV History – EV advantages – EV market – vehicle mechanics: roadway fundamentals- law of motion-vehicle kinetics- dynamics of vehicle motion – propulsion power–velocity and acceleration-propulsion system design.

UNIT II ENERGY SOURCE 9

Battery basics-lead acid battery–alternative batteries–battery parameters-technical characteristics–battery power–alternative energy sources: Fuel cells-Fuel Cell characteristics-Fuel cell types.

UNIT III SERIES HYBRID ELECTRIC DRIVE TRAIN DESIGN 9

Operation Patterns- Control Strategies-Sizing of the Major Components –Design of peaking power source- Traction Motor Size – Design of the Gear Ratio-Verification of Acceleration Performance-.Verification of grade ability–Design of Engine/Generator Size – Design of the Power Capacity-Design of the Energy Capacity –Fuel Consumption.

UNIT IV PARALLEL HYBRID ELECTRIC DRIVE TRAIN DESIGN 9

Control Strategies of ParallelHybridDriveTrain-DriveTrainParametersEnginePowerCapacity-Electric Motor Drive Power Capacity-Transmission Design- Energy Storage Design

UNIT V ELECTRIC VEHICLE DRIVE TRAIN 9

EV Transmission configurations–Transmission components–Ideal gear box–Gear ratio-torque–speed characteristics-EV motor sizing–initial acceleration-rated vehicle velocity–maximum velocity – maximum gradability.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Explain how a hybrid vehicle works and describe its main components and their function.
- **CO2 :** Choose proper energy storage systems for vehicle applications.
- **CO3 :** Design series hybrid electric vehicles.
- **CO4 :** Design parallel hybrid electric vehicles.
- **CO5 :** Describe the transmission components and their configurations for electric vehicles.
- **CO6:** Design the various electric vehicles.

TEXT BOOKS:

1. Ehsani,M, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press,2005.
2. Hybrid Electric Vehicle Technology Assessment: Methodology, Analytical Issues, and Interim Results,"Center for Transportation Research Argonne National Laboratory, United States Department of Energy.

REFERENCE BOOKS:

1. Iqbal Hussain, "Electric & Hybrid Vehicles– Design Fundamentals", Second Edition, CRC Press, 2011.
2. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.
3. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes 2000.http://nptel.ac.in/courses/108103009.

P23CCE52	VIRTUAL MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand the basic concept and types of Virtual Manufacturing, Virtual Prototyping and Virtual enterprise.
2. To learn the techniques of analyzing, validating and evaluating of manufacturing processes and preparation of production plans and schedules form design concepts.
3. To know simulation techniques and applying the same at different levels.

UNIT I BASIC CONCEPT AND TYPES OF VIRTUAL MANUFACTURING 9

Paradigms of VM: Design-centered VM, Production-centered VM and Control centered VM. Generic VM Issues – relationships between VM, Virtual Prototyping, the Virtual Enterprise. Role of object oriented technology in VM.

UNIT II DESIGN, OPTIMIZATION AND VALIDATION OF VIRTUAL MANUFACTURING 9

Promising areas of VM and manufacturability analysis, validation and evaluation of process plans, partnering in agile enterprises, process design, and optimization of production plans and schedules. Tools for manufacturability analysis.

UNIT III ADVANCED VIRTUAL MANUFACTURING TECHNOLOGY AND RESOURCE MODELS 9

Virtual Manufacturing over the Internet. Transmitting VM Information over the Internet. Manufacturing resource models for distributed manufacturing.

UNIT IV SIMULATION TECHNIQUES USED IN VIRTUAL MANUFACTURING 9

Manufacturing process simulation –Factory level, Machine level, Component level, Process level. Integrated Simulation Method to Support Virtual Factory Engineering. Application of Virtual Reality Simulation of a Mechanical Assembly Production Line.

UNIT V VIRTUAL FACTORY AND NETWORK MANUFACTURING 9

Dispersed Network Manufacturing – Virtual factory, enterprise collaborative modelling system, virtual manufacturing (VM) system, Web-based work flow management, and collaborative product commerce, applications of multi-agent technology, e-supply chain management and tele manufacturing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Understand the concept, types of Virtual Manufacturing and Virtual Prototyping.
- **CO2 :** Analyze, evaluate and validate manufacturing process plans with preparation of production plans and schedule and resource allocation.
- **CO3 :** Gain knowledge on use of IT tools for Virtual Manufacturing processes and preparation of Manufacturing Resource Models.
- **CO4 :** Apply the simulation techniques to Virtual Manufacturing Process Plans at different levels and applying Virtual Reality.
- **CO5 :** Develop virtual factory using Network concept and web based work flow management.
- **CO6:** Understand the Virtual Manufacturing with internet.

REFERENCE BOOKS:

1. Crabb, C. H., "The Virtual Engineer-21 st Century Product Development", Society of Manufacturing Engineers, 1998.
2. Rao Ming, Qu Wang, Jianzhong Cha, "Integrated Distributed Intelligent Systems in Manufacturing (Intelligent Manufacturing)", Chapman & Hall (1993).

P23CCE53	QUALITY CONCEPTS IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To impart knowledge on various concepts in engineering design, material selection and manufacturing methods.
2. To learn the principles of implementing quality in a product or services using different tools.
3. To enhance the quality of product by use of failure mode effect analysis and implement methods to uphold the status of six sigma.
4. To develop a robust product or service using various strategies of design of experiments.
5. To maintain the quality of the product by use of statistical tools and enforce methods to improve the reliability of a product.

UNIT I DESIGN FUNDAMENTALS, METHODS AND MATERIAL SELECTION **9**

Morphology of Design – The Design Process – Computer Aided Engineering – Concurrent Engineering – Competition Bench Marking – Creativity – Theory of Problem solving (TRIZ) – Value Analysis – Design for Manufacture, Design for Assembly – Design for casting, Forging, Metal Forming, Machining and Welding.

UNIT II DESIGN FOR QUALITY **9**

Quality Function Deployment –House of Quality-Objectives and functions-Targets-Stakeholders-Measures and Matrices-Design of Experiments –design process-Identification of control factors, noise factors, and performance metrics – developing the experimental plan- experimental design– testing noise factors- Running the experiments –Conducting the analysis-Selecting and conforming factor-Set points-reflecting and repeating.

UNIT III FAILURE MODE EFFECTS ANALYSIS AND DESIGN FOR SIX SIGMA **9**

Basic methods: Refining geometry and layout, general process of product embodiment – Embodiment checklist- Advanced methods: systems 80odelling, mechanical embodiment principles-FMEA method- linking fault states to systems 80odelling – Basis of SIX SIGMA – Project selection for SIX SIGMA- SIX SIGMA problem solving- SIX SIGMA in service and small organizations – SIX SIGMA and lean production –Lean SIX SIGMA and services.

UNIT IV DESIGN OF EXPERIMENTS **9**

Importance of Experiments, Experimental Strategies, Basic principles of Design, Terminology, ANOVA, Steps in Experimentation, Sample size, Single Factor experiments – Completely Randomized design, Randomized Block design, Statistical Analysis, Multifactor experiments –Two and three factor full Factorial experiments, 2K factorial Experiments, Confounding and Blocking designs, Fractional factorial design, Taguchi's approach – Steps in experimentation,Design using Orthogonal Arrays, Data Analysis, Robust Design- Control and Noise factors, S/N ratios.

UNIT V STATISTICAL CONSIDERATION AND RELIABILITY **9**

Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution-Statistical Process control–Scatter diagrams –Multivariable charts –Matrix plots and 3-D plots.-Reliability-Survival and Failure-Series and parallel systems-Mean time between failure-Weibull distribution.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Apply fundamentals of design process and material selection for developing a quality product.
- **CO2 :** Apply the quality concepts to develop a robust product.
- **CO3 :** Perform Failure Mode Effect Analysis on a product and use six sigma principles to enhance its quality.
- **CO4 :** Apply different experimental design methods in product development.
- **CO5 :** Implement various statistical tools to improve its quality and reliability.
- **CO6:** Understand the various quality concepts.

TEXT BOOKS:

1. Amitava Mitra, "Fundamentals of Quality control and improvement", John Wiley & Sons, 2016.
2. George E. Dieter, Linda C. Schmidt, "Engineering Design", McGraw Hill Education Pvt. Ltd., 2013.

REFERENCE BOOKS:

1. Karl T. Ulrich, Steven D. Eppinger, "Product Design And Development, Tata McGraw-Hill Education, 2015.
2. Kevin N. Otto and Kristin L. Wood, "Product Design: Techniques in Reverse Engineering and New Product Development", Prentice Hall, 2001.
3. Montgomery, D.C., "Design and Analysis of experiments", John Wiley and Sons, 2017.
4. Phillip J. Ross, "Taguchi techniques for quality engineering", Tata McGraw Hill, 2005.

P23CCE54	INDUSTRIAL SAFETY MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To achieve an understanding of principles of safety management.
2. To enable the students to learn about various functions and activities of safety department.
3. To enable students to conduct safety audit and write audit reports effectively in auditing situations.
4. To have knowledge about sources of information for safety promotion and training.
5. To 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 Machine shop – Cold bending and chamfering of pipes – metal cutting – shot blasting, 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 off site. Control of major industrial hazards.

UNIT IV ACCIDENT PREVENTION 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 boiler act – The environmental protection act – Electricity act – Explosive act.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : To understand the functions and activities of safety engineering department.
CO2 : To carry out a safety audit and prepare a report for the audit.
CO3 : To prepare an accident investigation report.
CO4 : List the safety measures.
CO5 : To estimate the accident cost using supervisors report and data.
CO6: To evaluate the safety performance of an organization from accident records.

TEXT BOOKS:

1. Industrial safety and the law by P.M.C. Nair Publisher's, Trivandrum.
2. John V. Grimaldi and Rollin H. Simonds, "Safety Management", All India Traveller's bookseller, New Delhi-1989.

REFERENCE BOOKS:

1. Krishnan N.V., "Safety in Industry", Jaico Publisher House, 1996.
2. Managing emergencies in industries, Loss Prevention of India Ltd., Proceedings, 1999.
3. Safety security and risk management by U.K. Singh & J.M. Dewan, A.P.H. Publishing company, New Delhi, 1996.

P23CCE55	MECHANICAL VIBRATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Students will learn about mechanical vibration in 1 DoF and 2 DoF systems.
2. Students will learn the basic concepts of vibration, mathematical modelling of vibration systems, formulate equations of motion, solve equations of motion to analyze vibration system response.
3. To enable students to conduct safety audit and write audit reports effectively in auditing situations.
4. To have knowledge about sources of information for safety promotion and training.
5. To familiarize students with evaluation of safety performance.

UNIT I FUNDAMENTALS OF VIBRATION 9

Review of Single degree freedom systems – Response to arbitrary periodic Excitations – Duhamel's Integral – Impulse Response function – Virtual work – Lagrange's equation – Single degree freedom forced vibration with elastically coupled viscous dampers – System Identification from frequency response – Transient Vibration – Laplace transformation formulation.

UNIT II TWO DEGREE FREEDOM SYSTEM 9

Free vibration of spring-coupled system – mass coupled system – Vibration of two degree freedom system – Forced vibration – Vibration Absorber – Vibration isolation.

UNIT III MULTI-DEGREE FREEDOM SYSTEM 9

Normal mode of vibration – Flexibility Matrix and Stiffness matrix – Eigen values and Eigen vectors – orthogonal properties – Modal matrix-Modal Analysis – Forced Vibration by matrix inversion – Modal damping in forced vibration – Numerical methods for fundamental frequencies.

UNIT IV VIBRATION OF CONTINUOUS SYSTEM 9

Systems governed by wave equations – Vibration of strings – vibration of rods – Euler Equation for Beams – Effect of Rotary inertia and shear deformation – Vibration of plates.

UNIT V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 9

Vibration instruments – Vibration exciters Measuring Devices – Analysis – Vibration Tests – Free and Forced Vibration tests. Examples of Vibration tests – Industrial, case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Understand the degrees of freedom.

CO2 : Know the fundamentals of vibration.

CO3 : Understand the engineering principles in mechanical system to identify, formulate and solve the problem of mechanical engineering.

CO4 : Able to find the source of engineering problems in mechanical system through research that includes identification, formulation, analysis, data interpretation based on engineering principles.

CO5 : To understand the 1DoF and 2DoF systems.

CO6: Able to formulate the solution of engineering problem in mechanical system by considering economy, safety, environment and energy conservation.

TEXT BOOKS:

1. W. T. Thomson, Marie Dillon Dahleh – "Theory of Vibration with Applications", Pearson; 5 edition,1 November 2013.
2. J.S.Rao, K. Gupta – "Introductory Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd., 1999.
3. Singiresu S. Rao, "Mechanical Vibrations," Pearson; Fourth edition, 2003.
4. Den Hartog, J.P, "Mechanical Vibrations," Dover Publications, 2013.

REFERENCE BOOKS:

1. Rao, Singiresu S., "Mechanical Vibrations", 5th Edition, Prentice Hall, 2013.
2. Kelly, S. Graham, "Mechanical Vibrations: Theory and Applications", SI Edition, Cengage Learning, 2011.
3. Timoshenko, S. "Vibration Problems in Engineering", Fifth Edition, John Wiley & Sons, Inc, 1990.
4. Leonard Meirovitch, "Elements Of Vibration Analysis", International Edition, McGrawHill, 1986.