



Two-Year Postgraduate Programme

Master of Technology

CAD-CAM Engineering

Faculty of Engineering & Technology

Parul University

Vadodara, Gujarat, India

Faculty of Engineering & Technology
Master of Technology in Mechanical Engineering

1. Vision of the Department

Exploring innovative approaches to enhance and expand learning opportunities through the integration of technology & building a strong research and teaching environment that responds to the real-time challenges of the industry.

2. Mission of the Department

M1 Educational Excellence: To deliver outstanding education across Mechanical disciplines, preparing students for successful careers in industry and advanced studies, while fostering a teaching environment that prioritizes depth, originality, and critical thinking.

M2 Research Empowerment: Empower graduates to excel in research across all facets of Mechanical Engineering, equipping them with the skills and knowledge needed for impactful contributions to the field.

M3 Cultivating Critical Minds: Foster a teaching environment that emphasizes depth, originality, and critical thinking, ensuring our students develop a strong foundation to tackle complex challenges in Mechanical Engineering and beyond.

3. Program Educational Objectives

The statements below indicate the career and professional achievements that the B.Tech. Mechanical Engineering curriculum enables graduates to attain.

PEO 1	Pursue successful career in engineering involving professional knowledge and skills for analysis, design and solution of real time engineering problems.
PEO 2	Excel in professional career with sound fundamental knowledge and pursue life-long learning including higher education and research.
PEO 3	Demonstrate interpersonal skills, leadership ability and team building to achieve organization goals and serve society with professional ethics and integrity.

4. Program Learning Outcomes

Program Learning outcomes are statements conveying the intent of a program of study.

PLO 1	Scholarship of Knowledge	Acquire in-depth knowledge of Thermal Engineering in professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge
PLO 2	Critical Thinking	Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make

		intellectual and/or creative advances for conducting research in all area.
PLO 3	Problem Solving:	Think laterally and originally, conceptualize and solve engineering problems, evaluate and arrive at feasible, optimal solutions after considering public issues in core areas of expertise.
PLO 4	Conduct investigations of complex problems	Extract information through literature survey and experiments; apply appropriate research methodologies & techniques to the development of scientific/technological knowledge in one or more domains of engineering.
PLO 5	Usage of modern tools	Create, select, learn and apply appropriate techniques, resources, and modern engineering and understanding it's limitations.
PLO 6	Collaborative and Multidisciplinary work	Possess knowledge and understanding of group dynamics to collaborative multidisciplinary research, demonstrate self-management, objectivity and rational analysis in order to achieve common goals and further learning of themselves as well as others.
PLO 7	Project Management and Finance	Demonstrate knowledge and management skills as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economic and financial factors.
PLO 8	Communication	Communicate with the engineering community at large, regarding complex engineering activities confidently and effectively by adhering to appropriate standards, make effective presentations and give/receive clear instructions.
PLO 9	Life-long Learning	Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
PLO 10	Ethical Practices and Social Responsibility	Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
PLO 11	Independent and Reflective Learning	Observe and examine critically the outcomes of one's actions and make corrective measures subsequently and learn from mistakes without depending on external feedback.

5. Credit Framework

Semester wise Credit distribution of the programme	
Semester-1	18
Semester-2	18
Semester-3	16
Semester-4	16
Total Credits:	68

Category wise Credit distribution of the programme	
Category	Credit
Major Core	40
Minor Stream	00
Multidisciplinary	00
Ability Enhancement Course	00
Skill Enhancement Courses	00
Value added Courses	00
Summer Internship	00
Research Project/Dissertation	28
Total Credits:	68

6. Program Curriculum

Semester 1						
Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
1	203200101	Research Methodology & IPR	2	2	0	0
2	203219101	Computer Graphics and Application in Design	4	3	2	0
3	203219102	Finite Element Analysis in Design and Manufacturing	4	3	2	0
4		AUDIT-1 (Compulsory Subjects :1)	AUDIT	2	0	0
5		Elective - 1 (Compulsory Subjects :1)	4	3	0	1
6		Elective - 2 (Compulsory Subjects :1)	4	3	0	1
Total			18	16	2	3

AUDIT-1 (Compulsory Subjects :1)						
1	203200102	English for Research Paper Writing	AUDIT	2	0	0
2	203200103	Disaster Management	AUDIT	2	0	0
3	203200104	Sanskrit for Technical Knowledge	AUDIT	2	0	0
4	203200105	Value Education	AUDIT	2	0	0
Elective - 1 (Compulsory Subjects :1)						
1	203217131	Design for Manufacturing and Assembly	4	3	0	1
2	203219130	Advanced Metrology and Inspection Techniques	4	3	0	1
3	203219131	Robotics and Industrial Automation	4	3	0	1
Elective - 2 (Compulsory Subjects :1)						
1	203217135	Analysis and Synthesis of Mechanisms	4	3	0	1
2	203219132	Advances in Materials and Manufacturing Technologies	4	3	0	1
3	203219133	Advanced Tool Design	4	3	0	1
Semester 2						
Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
7	203219151	Seminar & Mini Project	2	0	4	0
8	203219152	Computer Aided Manufacturing	4	3	2	0
9	203219153	Rapid Prototyping and Tooling	4	3	2	0
10		AUDIT-2 (Compulsory Subjects :1)	0	-	-	2
11		Elective - 3 (Compulsory Subjects :1)	4	3	0	1
12		Elective - 4 (Compulsory Subjects :1)	4	3	0	1
Total			18	12	8	4
AUDIT-2 (Compulsory Subjects :1)						
1	203200151	Constitution of India	AUDIT	-	-	2
2	203200152	Pedagogy Studies	AUDIT	-	-	2
3	203200153	Stress Management by Yoga	AUDIT	-	-	2
4	203200154	Personality Development through Life Enlightenment Skills	AUDIT	-	-	2
Elective - 3 (Compulsory Subjects :1)						
1	203217180	Tribology in Design	4	3	0	1
2	203219180	Computer Aided Process Planning	4	3	0	1
3	203219181	Computer Integrated Manufacturing	4	3	0	1
Elective - 4 (Compulsory Subjects :1)						

1	203219182	Concurrent Engineering	4	3	0	1
2	203219186	Hydraulics and Pneumatics	4	3	0	1
Semester 3						
Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
13	203219201	Phase - I Dissertation	10	0	20	0
14		Elective-5 (Compulsory Subjects :1)	3	3	0	0
15		Open Elective (Compulsory Subjects :1)	3	3	0	0
Total			16	6	20	0
Open Elective (Compulsory Subjects :1)						
1	203200203	Operation Research	3	3	0	0
2	203200204	Cost Management of Engineering Projects	3	3	0	0
3	203200205	Composite Materials	3	3	0	0
4	203200206	Waste to Energy	3	3	0	0
Elective-5 (Compulsory Subjects :1)						
1	203219230	Engineering Optimization	3	3	0	0
2	203219231	Artificial Intelligence and Expert Systems in Manufacturing	3	3	0	0
3	203219232	Product Design and Development	3	3	0	0
Semester 4						
Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
1	203206251	Dissertation Phase - II	16	0	32	0
Total			16	0	32	0

7. Detailed Syllabus

Semester 1

(1)

- a. **Course Name:** Research Methodology & IPR
- b. **Course Code:** 203200101
- c. **Prerequisite:** Knowledge of Electronics and Communication Systems and Technologies. Basic Computer Skills Fundamental Knowledge of Area of Interest in relevant discipline.
- d. **Rationale:** The objective of the course is intended to develop the research skills in a systematic manner which will impart the ability to select appropriate research methodology, experimental design, follow professional ethics and academic integrity, and develop oral and written presentation skills.
- e. **Course Learning Objective:**

CLOBJ 1	Evaluate the appropriateness of a research problem based on its focus, feasibility, and potential contribution to a field of study.
CLOBJ 2	Develop a research proposal that outlines a clear research question, methodology for data collection and analysis, and ethical considerations
CLOBJ 3	Critically analyze a research article, identifying its strengths and weaknesses in terms of research design, data interpretation, and argumentation
CLOBJ 4	Differentiate between the different types of intellectual property (patents, trademarks, copyrights) and explain their appropriate applications
CLOBJ 5	Develop a plan for protecting the intellectual property generated from your research, considering factors like patenting, licensing, and ethical implications.

f. Course Learning Outcomes:

CLO 1	Understand research problem formulation.
CLO 2	Analyze research related information.
CLO 3	Follow research ethics.
CLO 4	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
CLO 5	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
CLO 6	Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				T	CE	P	Theory	P	
2	0	0	2	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Unit 1 Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.	20%	5
2	Unit 2 Effective literature studies approaches, analysis Plagiarism, Research ethics	15%	5
3	Unit 3 Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	15%	5
4	Unit 4 Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, Patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	20%	5
5	Unit 5 Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	15%	5

6	Unit 6 New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	15%	5
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i. Text Book and Reference Book:

1. "Intellectual Property Rights Under WTO", By T. Ramappa, S. Chand, 2008.
2. "Research methodology: an introduction for science & engineering students", By Stuart Melville and Wayne Goddard, Juta & Co Ltd
3. "Research Methodology: A Step-by-Step Guide for Beginners", By Ranjit Kumar.
4. "Industrial Design", By Mayall, McGraw Hill, 1992
5. "Intellectual Property in New Technological Age", By Robert P. Merges, Peter S.

(2)

- a. Course Name:** Computer Graphics and Application in Design
- b. Course Code:** 203219101
- c. Prerequisite:** Fundamentals of Computer Aided Design
- d. Rationale:** This course is intended to give students greater depth of technical knowledge in the areas of design using modelling and analysis software. To enable the students to learn detailed engineering of 3D models & application of computer system to a solution of design problem.
- e. Course Learning Objective:**

CLOBJ 1	Recall and describe the stages of the product life cycle, basic 2D and 3D modeling principles, and specifications of a CAD workstation.
CLOBJ 2	Explain geometric transformations (translation, rotation, and scaling, shearing, reflection) and differentiate between curve types (Hermite cubic spline, Bezier) and surfaces in CAD.
CLOBJ 3	Use modeling and analysis software to generate 2D drafts and 3D models of mechanical components, creating assemblies with constraints and bills of material.
CLOBJ 4	Interpret industrial drawings, evaluate surface and solid modeling methods, and assess the impact of collaboration and data exchange standards on CAD file sharing.
CLOBJ 5	Synthesize knowledge to design visually appealing 3D models and assemblies, apply CAD standards to engineering drawings, and explore connections between CAD and machine learning, understanding classification techniques.

f. Course Learning Outcomes:

CLO 1	Use of computer aided drafting in product design and development process
CLO 2	Generate 2D drafting and 3D models of mechanical engineering components
CLO 3	Apply greater depths of technical knowledge in the areas of design using modeling and analysis software
CLO 4	Develop skills to read Industrial drawing
CLO 5	Generate assembly drawing and bill of material for a model
CLO 6	Able to implement design basics to industrial process of product development

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	2	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	FUNDAMENTALS OF CAD Introduction to CAD & Design process, Application of computer for design, Product Cycle & CAD-CAM, Benefits of CAD, Design work station & CAD hardware	14%	6
2	COMPUTER GRAPHICS Introduction to Computer graphics, Algorithm for generation of line, circle & ellipse, Clipping, Windows and View ports, 2D & 3D Transformation, Representation of curves and surfaces.	31%	14

3	GEOMETRIC MODELING Geometric modeling techniques, Wireframe modeling, Surface Modeling & Solid Modeling, Feature based Parametric and Variational modeling.	22%	10
4	COMPUTER APPLICATIONS IN DESIGN Geometric Tolerances, Mass property calculations, Mechanical Assembly, System customization & design automation, Programming techniques in drafting/ modeling/ analysis, Concept of computer animation, Reverse Engineering, Capabilities of various commercially available software in the area of CAD.	22%	10
5	CAD STANDARDS Standards in CAD, Graphics and computing standards, Data exchange standards, Design database, Interfacing design and drafting.	11%	5

i. Text Book and Reference Book:

1. "CAD/CAM Theory & Practice (TextBook)", By Ibrahim Zeid , Tata McGraw Hill.
2. "CAD/CAM Principles", By C. McMohan and J. Browne , Pearson Education , Second Edition.
3. "Computer Graphics", By Donald Hearn & M. Pauline Baker , PHI, 2011 , Second Edition
4. "CAD/CAM: Computer Aided design and Manufacturing", By Mikell Groover and Zimmer, Pearson Education
5. "CAD/CAM: Computer Aided Design and Computer Aided Manufacturing", by P K Jain, S Chand & Co.

(3)

- a. Course Name:** Finite Element Analysis in Design and Manufacturing
- b. Course Code:** 203219102
- c. Prerequisite:** Numerical Methods, Machine Design & Mechanics of Solids.
- d. Rationale:** The subject aims to introduce numerical methods for solving governing equations of mechanical systems. The class of problems include 1D and 2D structural, thermal and fluid problems as well as manufacturing related problems. Introduction to nonlinear and dynamic problems is also included.
- e. Course Learning Objective:**

CLOBJ 1	Students will identify specific applications of Finite Element Analysis (FEA) in design and manufacturing.
CLOBJ 2	Students will assess the computational procedures and analyze the impact of boundary conditions on One-Dimensional Elements.

CLOBJ 3	Students will demonstrate the ability to formulate element matrices and apply nodal loads-stress calculations for various types of elements.
CLOBJ 4	Students will analyze dynamic equations, examine mass and damping matrices, and evaluate solutions to numerical problems in structural dynamics.
CLOBJ 5	Students will apply FEA to formulate elements for heat transfer, address reduction techniques for nonlinear problems, and evaluate transient thermal analysis.

f. Course Learning Outcomes:

CLO 1	Students will be able to recall and describe the relevance of Finite Element Analysis (FEA) in design and manufacturing, demonstrating an understanding of its applications.
CLO 2	Students will apply computational procedures to analyze one-dimensional elements and assess the impact of boundary conditions, showcasing the ability to apply theoretical knowledge to practical scenarios.
CLO 3	Students will be capable of formulating element matrices for various elements and applying nodal loads-stress calculations, demonstrating proficiency in applying FEA techniques to solve engineering problems.
CLO 4	Students will analyze dynamic equations, interpret mass and damping matrices, and evaluate solutions to numerical problems in structural dynamics, demonstrating analytical and problem-solving skills.
CLO 5	Students will apply FEA to formulate elements for heat transfer, address reduction techniques for nonlinear problems, and evaluate transient thermal analysis.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	1	0	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	INTRODUCTION Relevance of finite element analysis in Design and Manufacturing, Modeling and discrimination, Interpolation, Elements, Nodes, and degrees-of-freedom. One-Dimensional Elements and Computational Procedures, Bar elements, Beam elements, Bar and beam elements of arbitrary orientation, Assembly of elements, Properties of stiffness matrices, Boundary conditions, Solution of equations, Mechanical loads and stresses, Thermal loads and stresses. Numerical.	30%	14
2	BASIC ELEMENTS Interpolation and shape functions, Element matrices, linear triangular elements (CST), Quadratic triangular elements, Bilinear rectangular elements, Quadratic rectangular elements, Solid elements, Higher order elements, Nodal loads-stress calculation. Numerical.	27%	12
3	FINITE ELEMENTS IN STRUCTURAL AND DYNAMIC APPLICATIONS One dimensional problems and static analysis of trusses, Analysis of plates, Solid of revolution, Dynamic equations, Mass and damping matrices, Numerical.	16%	7
4	FINITE ELEMENTS IN HEAT TRANSFER AND FLUID MECHANICS APPLICATIONS Heat Transfer, Element formulation, Reduction - nonlinear problems, Transient thermal analysis. Fluid structure interaction problems, Plane incompressible and rotational flows, Numerical	11%	5
5	FINITE ELEMENTS IN MANUFACTURING FE analysis of Metal casting, latent heat incorporation, time stepping procedure, Analysis of metal forming- sheet metal stamping, Analysis of Metal cutting, chip separation criteria, incorporation of strain rate dependency, Numerical.	16%	7

i. Text Book and Reference Book:

1. "Finite Element Procedure", By Bathe, Prentice Hall.
2. "Introduction to Finite Elements in Engineering", By Chandrupatla, R.T. & Belegundu, A.D
3. "CAD/CAM Theory and Practice", By Ibrahim-Zeid.
4. "The Finite Element Method", By Zienkiewicz. O.C.

(4)

- a. **Course Name:** Design for Manufacturing and Assembly
- b. **Course Code:** 203217131
- c. **Prerequisite:** Knowledge of Manufacturing Engineering, Machine Design
- d. **Rationale:** The course is prepared to provide the detailed understanding of the Manufacturing and Assembly
- e. **Course Learning Objective:**

CLOBJ 1	Develop a comprehensive understanding of the design process stages
CLOBJ 2	Cultivate analytical skills to make informed decisions in material selection, manufacturing processes, and design for manufacturing
CLOBJ 3	Enhance the ability to evaluate the effectiveness of diverse manufacturing processes and apply principles of design
CLOBJ 4	Acquire the knowledge and skills to optimize designs, with a focus on reliability and quality
CLOBJ 5	Develop a robust design approach, demonstrating proficiency in designing engineering solutions that prioritize reliability, quality, and optimization.

- f. **Course Learning Outcomes:**

CLO 1	Apply the design process stages, including problem definition and material and shape selection, demonstrating a comprehensive understanding.
CLO 2	Analyze and make informed decisions in material selection, manufacturing processes, and design for manufacturing through case studies.
CLO 3	Evaluate the effectiveness of various manufacturing processes and apply principles of design
CLO 4	Apply knowledge of failure mode analysis and design principles to optimize reliability and quality in engineering applications.
CLO 5	Develop a robust design approach, showcasing proficiency in design optimization for engineering solutions.

- g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	1	0	4	20	20	20	60	30	150

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Introduction Identification of problem, concept generation and evaluation, Embodiment design, selection of materials and shapes.	20%	9
2	Properties of Engineering Materials Selection of materials – I, selection of materials – II, case studies – I, selection of shapes, Co- selection of materials and Shapes, case studies – II	20%	9
3	Design for Manufacturing Selection of Manufacturing Processes, review of manufacturing processes, Design for Casting, Design for Bulk Deformation Processes, Design for Sheet Metal Forming Processes, Design for Machining, Design for Powder Metallurgy, Design for Polymer Processing, Coselection.	20%	9
4	Design for Assembly Review of Assembly Processes, Design for Welding – I, Design for Welding – II, Design for Brazing and Soldering, Design for Adhesive Bonding, Design for Joining.	20%	9
5	Design for Reliability Failure Mode and Effect Analysis and Quality, Design for Quality, Design for Reliability, Approach to Robust Design, Design for Optimization.	20%	9

i. Text Book and Reference Book:

1. “Materials and Design”, By M F Ashby and K Johnson; Butterworth Heinemann
2. “Engineering Design - A Material Processing Approach”, By G E Dieter; McGraw Hill
3. “Mechanical Behavior of Materials”, By T H Courtney; McGraw Hill.

(5)

- a. **Course Name:** Advanced Metrology and Inspection Techniques
- b. **Course Code:** 203219130
- c. **Prerequisite:** Mechanical Measurement
- d. **Rationale:** The student will be exposed to modern inspecting techniques along with the classical metrology. Along with the metrology, design of experiments and techniques for analysis of acquired data are also included in the course. Students will learn how to simulate the real-life situations in different environments.
- e. **Course Learning Objective:**

CLOBJ 1	Understand the importance of calibration in ensuring accuracy, traceability for establishing measurement standards, and managing uncertainty for reliable measurements in metrology.
CLOBJ 2	Recognize measurement errors and propose techniques to minimize them, ensuring precision and reliability in the metrology process.
CLOBJ 3	Analyze various methods and devices used in dimensional metrology to measure and assess the size and geometry of objects accurately.
CLOBJ 4	Develop skills in designing limit gauges, essential tools for verifying the acceptability of dimensional characteristics, promoting quality control in manufacturing.
CLOBJ 5	Evaluate surface roughness and form errors using computer-aided inspection techniques to enhance the understanding and control of surface quality in manufacturing processes.
CLOBJ 6	Apply the principles of calibration and traceability to ensure that measurement instruments are reliable, consistent, and aligned with established standards, fostering accuracy in metrology.

f. Course Learning Outcomes:

CLO 1	Students will conceptualize fundamentals of metrology
CLO 2	Explain various basic techniques of metrology.
CLO 3	Apply advanced techniques of metrology.
CLO 4	Devise innovative techniques for measurement and inspection
CLO 5	Apply computer-aided measurement and inspection techniques
CLO 6	Comprehend the importance of accuracy in precision measurements

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation		ESE			Total
				MSE	CE	T	Theory	P	
3	1	0	4	60	30	20	20	20	15

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	INTRODUCTION: Concept of accuracy, Need for high precision measurement, Accuracy of numerical control system, Inaccuracy due to thermal aspects, Detailed surface roughness concept, Dimensioning & Dimensional chains, Surface and form metrology flatness, roughness, waviness cylindricity, Methods of improving accuracy & surface finish, Influence of forced vibration on accuracy Dimensional wear of cutting tools and its influences on accuracy.	15%	7
2	LASER METROLOGY: Free electron laser – optical alignment, measurement of distance – interferometry, reversible counting, refractive index correction, reversible counting, refractive index correction, surface topography and optical component testing, pulse-echo techniques surface velocity Measurements using speckle patterns– laser spectroscopy – modular beam spectroscopy.	20%	10
3	HOLOGRAPHY: Basic principles, holographic interferometry, double exposure holographic, interferometry, sandwich holograms, real time holography, and time- average holographic.	15%	7

4	COORDINATE MEASURING MACHINE: Coordinate metrology, CMM configurations, hardware components, Software, Probe sensor, Displacement device, Performance Evaluations, Dynamics errors, Thermal effects diagram, Temperature variations environment control, Applications	15%	7
5	COMPUTER AIDED MEASUREMENT AND INSPECTION: Computer Aided Testing, Contact type, non-contact type simulation, Major activities, Purpose, Simulation process, Types methodology, Simulation packages, Process quality simulator, Computer requirements trends and applications simulation machine shop. Co-ordinate measuring machines, Universal measuring machine, Laser viewers for production profile checks, Image shearing microscope -Use of computers, Machine vision technology, Microprocessors in metrology.	30%	7

i. Text Book and Reference Book:

1. "Metrology and Measurement", By A. K. and Kulkarni, V. A; Tata McGraw Hil Publishing Company Ltd.
2. "Lasers – Principles, Types and Applications", By Nambikar K, New Age International Limited Publishers.
3. "Co-ordinate Measuring Machines and Systems", By Bosch J A, Giddings and Lewis Dayton; Marcel Dekker.
4. "Industrial Metrology", by Smith G Springer.

(6)

- a. Course Name:** Robotics and Industrial Automation
- b. Course Code:** 203219131
- c. Prerequisite:** Fundamentals of Robotics and Hydraulics and Pneumatics.
- d. Rationale:** This subject aims to give exposure regarding the novel and promising techniques in the area of Robotics and Automation. Different techniques and elements of automation and study their role in Industrial scenario will be studied.
- e. Course Learning Objective:**

CLOBJ 1	Understand the fundamental concepts and principles of industrial automation and robotics.
CLOBJ 2	Explain the role of industrial automation in increasing productivity in different industrial scenarios.

CLOBJ 3	Demonstrate the ability to develop virtual and real models of manufacturing scenarios and conduct rigorous testing.
CLOBJ 4	Analyze different configurations of industrial robotic systems and understand their suitability for specific applications.
CLOBJ 5	Evaluate the effectiveness of different robotic configurations in meeting specific industrial requirements.

f. Course Learning Outcomes:

CLO 1	Understand the applications of industrial robots in reducing human work and improving efficiency.
CLO 2	Apply the knowledge to develop and test virtual and real models of manufacturing scenarios.
CLO 3	Analyze configurations of industrial robotic systems for specific applications.
CLO 4	Design efficient and reliable robotic systems based on knowledge of automation techniques.
CLO 5	Evaluate the suitability and effectiveness of different robotic configurations for specific industrial requirements.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	1	0	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination.

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Introduction to Automation Introduction, applications, goals, issues of automation, Advantages, problems of automation, Low-cost automation, Elements & Hardware components.	11%	5

2	Automation in Production Automated work piece handling, working principles & techniques, Construction elements of automation, Transfer lines unit build machines, special purpose machines & machining centers, Assembly automation, use of pneumatic & hydraulic system for automation.	11%	5
3	Hydraulic Control in Automation Introduction & principles of fluid power transmission, Applications of fluid power in Industrial Automation, Study of elements of Hydraulic system, Design, analysis and study of typical hydraulic & pneumatic systems.	27%	12
4	Fundamental of Industrial Robotics Specifications, Characteristics, Components, Configurations, Selection criteria & Applications.	4%	2
5	Robotic Control System, End Effectors & Sensors Drives, Robot Motions, Actuators, Power Transmission systems, Robot Controllers & Dynamic Properties of Robots, Transducers & Sensors, End Effectors, and Active & Passive Elements.	16%	7
6	Robot Programming Methods of Programming, Study of various Programming Languages.	9%	4
7	Robot Arm Kinematics & Dynamics Direct Kinematics and Solutions, Inverse Kinematics and Solutions, Robot Arm Dynamics, Lagrange & Newton Euler Formulations, Generalized D'Alembert's Equation of Motion.	22%	10

i. Text Book and Reference Book:

1. "Automation, Production Systems, and Computer-Integrated Manufacturing", By Mikell P. Groover.
2. "Introduction to Robotics", By S. K. Saha
3. "Introduction to Robotics: Analysis, Control, Applications", By Saeed B.Niku.

(7)

- a. **Course Name:** Analysis and Synthesis of Mechanisms
- b. **Course Code:** 203217135
- c. **Prerequisite:** Knowledge of Kinematics and Dynamics of Machines.
- d. **Rationale:** The course on Analysis and Synthesis of Mechanisms is essential to provide students with a solid foundation in the basic concepts of mechanical systems, ensuring a clear understanding of kinematic principles, dynamics, and degrees of freedom. Furthermore, the focus on Kinematic Synthesis of planar mechanisms, Design of four-link mechanisms, and Coupler Curves equips students

with practical skills to systematically design mechanisms, addressing specific application requirements and gaining insights into the dynamic behavior through graphical analysis.

e. Course Learning Objective:

CLOBJ 1	Develop a foundational understanding of basic concepts in mechanism analysis, including the definition of mechanisms, kinematic principles, dynamic considerations, and degrees of freedom.
CLOBJ 2	Learn and apply curvature theory to analyze the motion of mechanisms, with a focus on path generation and velocity analysis to understand the geometric aspects of motion.
CLOBJ 3	Acquire skills in kinematic synthesis, particularly in the context of planar mechanisms, by understanding precision points, linkages, and the systematic design process for achieving desired motion characteristics.
CLOBJ 4	Develop proficiency in designing four-link mechanisms by applying the principles of kinematic synthesis and considering specific application requirements, such as motion constraints and performance specifications.
CLOBJ 5	Explore and analyze coupler curves within mechanisms using graphical methods.
CLOBJ 6	Develop the ability to integrate analysis and synthesis techniques to achieve a comprehensive understanding of mechanisms. Apply learned principles to solve real-world engineering problems involving the design and analysis of mechanisms.

f. Course Learning Outcomes:

CLO 1	Understand basic concepts of mechanism analysis, including kinematics, dynamics, and degrees of freedom.
CLO 2	Apply Curvature Theory to analyze and interpret geometric aspects of mechanism motion, emphasizing path generation and velocity analysis.
CLO 3	Demonstrate the application of Kinematic Synthesis principles in the design of planar mechanisms, utilizing precision points and systematic approaches.
CLO 4	Assess and design four-link mechanisms, integrating kinematic synthesis principles to meet specific application requirements and performance criteria.
CLO 5	Analyze Coupler Curves within mechanisms using graphical methods, providing insights into the motion characteristics of the coupler link.
CLO 6	Integrate analysis and synthesis techniques to solve complex engineering problems.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	1	-	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Basic Concepts Definitions and assumptions; planar and spatial mechanisms; kinematic pairs; degree of freedom; equivalent mechanisms; Kinematic Analysis of Planar Mechanisms. Review of graphical and analytical methods of velocity and acceleration analysis of kinematically simple mechanisms, velocity-acceleration, analysis of complex mechanisms by the normal acceleration and auxiliary-point methods.	15%	8
2	Curvature Theory Fixed and moving centrodes, inflection circle, Euler-Savary equation, Bobillier constructions, cubic of stationary curvature, Ball's point Applications in dwell mechanisms.	15%	8
3	Kinematic Synthesis of planar mechanisms Accuracy (precision) points, Chebyshev spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two, three and four accuracy points using pole method, center a circle point curves, Analytical synthesis of four-bar and slider-crank mechanisms.	30%	11
4	Design of four link mechanisms Freudenstein's equation, synthesis for four and five accuracy points, compatibility condition, synthesis of four-bar for prescribed angular velocities and accelerations.	20%	9

5	Coupler Curves Equation of coupler curve, Robert-Chebyshev theorem, double points and symmetry.	20%	9
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i. Text Book and Reference Book:

1. "Kinematic Synthesis of Linkages", By R.S. Hartenberg and J. Denavit McGraw-Hill, New York, 1980,
2. "Design of Machinery", By Robert L. Norton, Tata McGraw Hill Edition.
3. "Mechanisms and Dynamics of Machinery", By Hamilton H. Mabie, John Wiley and sons New York
4. "Mechanisms for Engineering Design", By S.B. Tuttle, John Wiley and sons New York
5. "Theory of Machines and Mechanisms", By A. Ghosh and A.K. Mallik, Affiliated East-West Press, New Delhi, 1988.
6. "Mechanism Design – Analysis and Synthesis", (Vol. 1 and 2), By A.G. Erdman and G.N. Sandor, Prentice Hall India, Pub. Year 1988.

(8)

- a. Course Name:** Advances in Materials and Manufacturing Technologies
- b. Course Code:** 203219132
- c. Prerequisite:** Manufacturing Processes and Production Technology
- d. Rationale:** The subject aims to introduce to the students about novel and promising techniques in the area of Material and Manufacturing Technology. Detailed study about plastics, composites, smart materials and non-material. Students will learn how to simulate the real-life situations in different environments.
- e. Course Learning Objective:**

CLOBJ 1	Understand novel machining techniques.
CLOBJ 2	Decide the design parameters using composites.
CLOBJ 3	Understand various materials and material processing techniques.
CLOBJ 4	Decide parameters for various material processing techniques.
CLOBJ 5	Finalize the effect of process parameters for various material processing techniques.

f. Course Learning Outcomes:

CLO 1	Learn about a wide range of novel machining techniques.
CLO 2	Understand the improvement in design parameters using composites.
CLO 3	Discuss various materials and material processing techniques.

CLO 4	Compare influence of material parameters for various material processing techniques.
CLO 5	Explain effect of process parameters for various material processing techniques.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	1	-	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Introduction to Materials Classification of materials, properties of materials, Engineering requirements of materials, Imperfections in materials, Selection of materials for engineering applications, Plastic material, Phase Diagrams, Phase transformations in metals, Solidification in metals and alloys, Mechanical properties of materials, Failure in materials	10%	04
2	Composite Materials Reinforcement, reinforced concrete, Metal matrix composite (MMC), Ceramic matrix composite, Reinforced plastics, Fatigue failure in particulate composite material, Advanced composite materials (ACM), Corrosion of materials, Diamond material, CBN, Non-destructive testing of materials, Industrial Application	30%	12

3	Advances in Machining Processes Advances in Metal Welding processes. Principle, constructional details of unconventional & hybrid processes. Advanced processes like explosive forming, water hammer forming etc. Surface deposition processes and its variants. Micromachining processes.	20%	08
4	Modelling & Simulation of Manufacturing Processes Introduction to Modelling, Simulation and Analytical Models. Simulation Programming Languages. Design and Analysis of Experiments.	20%	08
5	Virtual Manufacturing Introduction, principles of virtual reality, Architecture, Virtual reality modelling languages. Telecollaborative Manufacturing. Lean Manufacturing.	20%	08

i. Text Book and Reference Book:

1. "Materials Science and Engineering", By William D. Callister , John Willey and Sons Inc. Singapore.
2. "Advanced Machining Processes", By V.K. Jain ,Allied Publishers.
3. "Manufacturing Engineering & Technology", By S.Kalpajian ,Prentice Hall.
4. "Performance Modelling of Automated Manufacturing Systems", By Viswanadham, Nand Narahari,Y. Prentice Hall of India, New Delhi.
5. "Systems Simulation", By Gordon G ,Prentice Hall of India Ltd.
6. "Virtual Manufacturing", By Prashant Banerjee, Wiley.

(9)

a. Course Name: Advance Tool Design

b. Course Code: 203219133

c. Prerequisite: Manufacturing Processes and Production Technology

d. Rationale: The subject aims to introduce to the students about to design of various tooling such as cutting tools, jigs and fixtures, press, tools and CNC machine tools. Students will learn how to simulate the real-life situations in different environments.

e. Course Learning Objective:

CLOBJ 1	Identify the role of tool engineering in manufacturing and classify different types of tools, understanding their design objectives.
CLOBJ 2	Apply a systematic design procedure, including needs analysis, research, and ideation, to produce finished tool designs.

CLOBJ 3	Analyze the mechanics of metal cutting, including oblique and orthogonal cutting, chip formation, and shear angle.
CLOBJ 4	Design single-point cutting tools, milling cutters, hole-making cutting tools, and various fixtures, applying principles of location and clamping.
CLOBJ 5	Classify types of press tool dies, design components such as pilots and strippers, and calculate clearance and cutting forces for different die operations.

f. Course Learning Outcomes:

CLO 1	Students will recall and explain key principles of tool engineering, classifications, and design objectives in manufacturing.
CLO 2	Students will proficiently apply a systematic tool design procedure, incorporating needs analysis, research, ideation, and producing finished designs.
CLO 3	Students will analyze the mechanics of metal cutting, demonstrating an understanding of oblique and orthogonal cutting, chip formation, and shear angle.
CLO 4	Students will design cutting tools, jigs, fixtures, and press tool dies, showcasing competence in applying design principles.
CLO 5	Students will evaluate the effectiveness of their designs, considering specified requirements and standards.
CLO 6	Students will integrate knowledge across modules to solve complex problems in tool design for manufacturing

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	2	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	INTRODUCTION TO TOOL DESIGN: Introduction, Tool Engineering, Tool Classifications, Tool Design Objectives, Tool Design in manufacturing, Challenges and requirements, Standards in tool design, Tool drawings, Fits and Tolerances, Tooling Materials, Ferrous and Nonferrous Tooling Materials Carbides, Ceramics and Diamond -Nonmetallic tool materials, Designing with relation to heat treatment, Tooling materials, properties of tool materials,	35%	15
2	DESIGN OF CUTTING TOOLS: Mechanics of Metal cutting, Oblique and orthogonal cutting, Chip formation and shear angle, Single-point cutting tools, milling cutters, Hole making cutting tools, Broaching Tools, Design of Form relieved and profile relieved cutters, Design of gear and thread milling cutters.	20%	9
3	DESIGN OF JIGS AND FIXTURES: Introduction, Types of Gage, Gage Tolerances, Selection of material for Gages, Principles of location, Locating methods and devices, Principles of clamping, Drill jigs, Chip formation in drilling, General considerations in the design of drill jigs, Drill bushings, Methods of construction, Thrust and Turning Moments in drilling, Drill jigs and modern manufacturing, Types of Fixtures – Vise Fixtures, Milling Fixtures, Boring Fixtures, Broaching Fixtures, Lathe Fixtures, Grinding Fixtures, Modular Fixtures, Cutting Force Calculations.	25%	12
4	DESIGN OF PRESS TOOL DIES: Types of Dies –Method of Die operation, Clearance and cutting force calculations, Blanking and Piercing die design, Pilots, Strippers and pressure pads, Presswork materials, Strip layout, Short-run tooling for Piercing, bending dies, forming dies, drawing dies-Design and drafting.	20%	9

Text Book and Reference Book:

1. "Tool Design", By Cyril Donaldson, George H.LeCain, V.C. Goold; Tata McGraw Hill Publishing Company Ltd, 2000.
2. "Tooling Data", By Prakash Hiralal Joshi; Wheeler Publishing, 2000.
3. "Jig and Fixture Design", By E.G. Hoffman; Thomson Asia Pvt Ltd, Singapore, 2004.
4. "Manufacturing Technology", By Haslehurst M; the ELBS, 1978

Semester 2

(1)

- a. **Course Name:** Computer Aided Manufacturing
- b. **Course Code:** 203219152
- c. **Prerequisite:** Knowledge of Computer Aided Design
- d. **Rationale:** The course is prepared to provide the detailed understanding of the Computer Aided Design related to Manufacturing.
- e. **Course Learning Objective:**

CLOBJ 1	Develop a foundational understanding of CAM concepts, NC/CNC machine components
CLOBJ 2	Apply knowledge of CNC hardware components, such as recirculating ball screws and tooling requirements, to practical manufacturing processes.
CLOBJ 3	Evaluate spindle drives, feed drives, and control systems in CNC machines to determine their suitability for diverse manufacturing applications.
CLOBJ 4	Attain proficiency in part programming, utilizing concepts like G & M codes and computer-assisted programming, to optimize CNC machining efficiency.
CLOBJ 5	Apply principles of Flexible Manufacturing Systems (FMS) and automated part programming techniques for CAD-based NC program generation

f. Course Learning Outcomes:

CLO 1	Understand CAM concepts, NC/CNC machine components, and the role of manufacturing engineers in CIM.
CLO 2	Apply knowledge of CNC hardware, including recirculating ball screws and tooling requirements, in manufacturing processes.
CLO 3	Analyze and evaluate the suitability of spindle drives, feed drives, and control systems in CNC machines.
CLO 4	Apply part programming concepts, including G & M codes and computer-assisted programming, for efficient CNC machining.
CLO 5	Apply principles of Flexible Manufacturing Systems (FMS) and automated part programming techniques for CAD-based NC program generation.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	2	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	INTRODUCTION CAM Concepts, Types of Manufacturing system, Benefits of CAM, Concept of Computer Integrated Manufacturing, Role of manufacturing Engineers, CIM wheel.	9%	4
2	NC AND CNC MACHINES Introduction to NC/CNC, History, Classification of CNC Machines, Component of NC/CNC machines, Specification of CNC, NC motion system, Axis Designation, tape, tape format, tape code and tape readers used in NC machine, open loop system, closed loop system, feedback devices, Controllers, Sensors and Actuators, Direct Numerical Control (DNC), Working principle of DNC, DNC components. CNC hardware: recirculating ball screw, anti-friction slides, NC/CNC tooling, Automatic tool changers (ATC), automatic pallet changers (APC). Tooling requirements of CNC machine, preset and qualified tools, work and tool holding devices in CNC machines.	31%	14
3	SYSTEM DRIVES AND CONTROL SYSTEMS Spindle Drives: DC shunt motor and 3-phase AC induction motor, Feed drives: stepper motor, servo motor, DC & AC servo motors, Control system: Types of encoders, absolute and incremental optical encoders.	11%	5

4	NC/CNC PART PROGRAMMING Introduction, controllers, Types of controller, structure of part programming, G & M codes, Types of format, manual part programming for lathe and milling machine operations, Concepts of tool length and radius compensation, subroutines, do loops, canned cycles for lathe & milling, sub programming. Computer assisted part programming: need, list of computer assisted programming languages, Automated Programmed Tools language (APT) - its types of statement, command, Fundamentals of Macros.	29%	13
5	FLEXIBLE MANUFACTURING SYSTEM Introduction, Need of FMS, General Considerations for FMS, components of a FMS, types of FMS, flexibilities and types, measurement techniques, Applications of FMS, workstation, planning the FMS, Automated material handling systems; types of Application, AS/RS, AGV, Manufacturing cells, concept of cellular manufacturing, group technology and just in time.	16%	7
6	AUTOMATED PART PROGRAMMING Automatic NC program generation from CAD models using software, Comparison of different Toolpath strategies in CAM Software.	4%	2

i. Text Book and Reference Book:

1. "Computer Numerical Control (TextBook)", By P. Radhakrishnan; New Central Book Agency, Engineering Design - A Material Processing Approach, G E Dieter; McGraw Hill
2. "Cnc Technology and Programming (TextBook)", By Tilak Raj; Dhanpat Rai Publishing Company Private Limited-New Delhi; 1st, 2014, Mechanical Behavior of Materials, T H Courtney; McGraw Hill.
3. "CAD/CAM and Automation", By Farazdak Haideri, Nirali Prakashan (TextBook)
4. "CAD/CAM Theory & Practice (TextBook)", Ibrahim Zeid, Sivasubramanian, Tata Mcgraw Hill Publishing Co Ltd, 2015

(2)

- a. Course Name:** Rapid Prototyping and Tooling
- b. Course Code:** 203219153
- c. Prerequisite:** Manufacturing Processes and Production Technology.
- d. Rationale:** This subject aims to familiarize the students with the modern prototyping tool Rapid prototyping, its types and applications.

e. Course Learning Objective:

CLOBJ 1	Define and explain the key concepts and principles of rapid prototyping and tooling, including the evolution of the technology and its role in modern manufacturing mechanical design.
CLOBJ 2	Utilize computer-aided design (CAD) tools for rapid prototyping, with a focus on creating 3D solid models and generating STL or SLA files from these models.
CLOBJ 3	Evaluate and compare liquid-based processes (e.g., SLA) and powder-based processes (e.g., selective laser sintering) in terms of principles, typical processes, and applications.
CLOBJ 4	Investigate solid-based rapid prototyping processes, such as fused deposition modeling (FDM) and laminated object modeling (LOM), understanding their principles and typical applications.
CLOBJ 5	Analyze the principles and processes involved in rapid tooling for quick batch production of plastic and metal parts, considering the cost-effectiveness and efficiency of these methods.

f. Course Learning Outcomes:

CLO 1	Demonstrate an understanding of the evolution of rapid prototyping and tooling, recognizing its significance in modern manufacturing mechanical design.
CLO 2	Apply CAD tools to create 3D solid models and generate STL or SLA files, showcasing proficiency in using computer-aided design for rapid prototyping.
CLO 3	Evaluate and compare liquid and powder-based rapid prototyping processes, demonstrating the ability to analyze the principles and applications of different technologies.
CLO 4	Investigate and understand solid-based rapid prototyping processes, demonstrating the ability to synthesize knowledge to assess the principles and applications of technologies like FDM and LOM.
CLO 5	Analyze the principles and processes of rapid tooling for quick batch production, evaluating the cost-effectiveness and efficiency of these methods through case studies and practical applications.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	2	0	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	INTRODUCTION Definitions, evolution, CAD for RPT. Product design and rapid product development. The cost and effects of design changes during conceptual modeling, detail designing, prototyping, manufacturing and product release. Fundamentals of RPT technologies, various CAD issues for RPT. RPT and its role in modern manufacturing mechanical design. 3D solid modeling software and their role in RPT. Creation of STL or SLA file from a 3D solid model.	20%	9
2	LIQUID AND POWDER BASED RP PROCESSES Liquid based process: Principles of STL and typical processes such as the SLA process, solid ground curing and others - Powder based process: Principles and typical processes such as selective laser sintering and some 3D printing processes.	20%	9
3	SOLID BASED RP PROCESSES Principles and typical processes such as fused deposition modeling; laminated object modeling and others.	20%	9
4	RAPID TOOLING Principles and typical processes for quick batch production of plastic and metal parts through quick tooling.	20%	9

5	REVERSE ENGINEERING 3D scanning, 3D digitizing and Data fitting. High-speed machining- Hardware and software - Applications: Evaluation, benchmarking and various case studies.	20%	9
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i. Text Book and Reference Book:

1. "Rapid Prototyping: A Brief Introduction (TextBook)", By Ghosh A; Affiliated East West.
2. "Rapid Prototyping Technology: Selection and Application (TextBook)", By Kenneth G. Cooper; CRC Press
3. "Rapid Prototyping: Principles and Applications (TextBook)", By Chua Chee Kai, Leong Kah Fai, Lim Chu Sing Lim; World Scientific; 2nd, 2010

(3)

- a. **Course Name:** Tribology in Design
- b. **Course Code:** 203217180
- c. **Prerequisite:** Fluid Mechanics, Material Science
- d. **Rationale:** Majority of mechanical equipment / mechanisms involve relative motion of links or parts. The course intends to impart concepts of tribology. Application of tribology in design of mechanical components is also introduced.
- e. **Course Learning Objective:**

CLOBJ 1	Understand the fundamental concepts of tribology, including friction, wear, and lubrication.
CLOBJ 2	Establish design criteria considering tribological factors, such as minimizing wear, reducing friction, and enhancing lubrication.
CLOBJ 3	Understand the tribological properties of materials and how to select materials based on their friction, wear, and lubrication characteristics. Explore the influence of material properties on tribological performance.
CLOBJ 4	Integrate lubrication systems into the design to ensure optimal tribological performance.
CLOBJ 5	Design bearings and seals with a focus on minimizing friction, preventing wear, and ensuring effective sealing. Incorporate materials and geometries that enhance tribological performance.
CLOBJ 6	Explore surface engineering techniques and coatings to improve the tribological properties of surfaces.

f. Course Learning Outcomes:

CLO 1	Understand the fundamental of tribology and its importance.
CLO 2	Understand and explain different laws of friction and topology of surfaces.
CLO 3	Identify and solve surface problem by tribological techniques.
CLO 4	Apply theories of friction and wear to various practical situations by analyzing the physics of the process.
CLO 5	Understand the various surface measurement techniques and effect of surface texture on Tri-biological behaviour of a surface.
CLO 6	Select materials and lubricants to suggest a tribological solution to a particular situation.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	1	0	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	INTRODUCTION: Introduction to tribology and its historical background. Factors influencing tribological phenomena. Introduction to tribological processes and tribological relevant properties of materials. An overview of engineering materials having potential for tribological application.	11%	5

2	SURFACES, FRICTION AND WEAR Engineering surfaces - Surface characterization, Computation of surface parameters. Surface measurement techniques, Apparent and real area of contact. Contact of engineering surfaces- Hertzian and non-hertzian contact. Contact pressure and deformation in non-conformal contacts. Genesis of friction, friction in contacting rough surfaces, sliding and rolling friction, causes of friction, Friction of metals and non-metals, Various laws and theory of friction. Stick-slip friction behavior, frictional heating and temperature rise. Friction measurement techniques. Definition of wear and wear types. Mechanisms of wear - Adhesive, abrasive, corrosive, erosion, fatigue, fretting, etc., Wear of metals and nonmetals. Wear models - asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage. Wear in various mechanical components, wear controlling techniques.	31%	14
3	LUBRICATION Lubricants and their physical properties, lubricants standards, Additives and selection of Lubricants- Lubrication regimes, Hydrodynamic lubrication, Reynolds Equation, Thermal - Inertia and turbulent effects, Elasto -hydrodynamic and plasto- hydrodynamic theory-soft and hard EHL-Reynolds equation-film shape and thickness within and outside contact zones-Hydro static lubrication, Gas Lubrication	18%	8
4	DESIGN OF TRIBOLOGICAL ELEMENTS Tribological consideration in design, Mechanisms of tribological failures in machines, Design of Fluid Frictional Elements- Fluid friction concepts, Design of hydro dynamically loaded journal bearings, externally pressurized bearings, Rolling elements bearings, Performance analysis of bearings, gears, mechanical seals, piston rings, machine tool slide ways, cams and follower.	31%	14

5	TRIBO MEASUREMENT INSTRUMENTATION Surface topography measurements - Electron microscope and friction and wear measurements - Laser method - Instrumentation - International standards - Bearings performance measurements - Bearing vibration measurement.	9%	4
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i. Text Book and Reference Book:

1. "Principles and Applications of Tribology", By Bharat Bhushan , Wiley India
2. "Basic Lubrication Theory (TextBook)", By A.Cameron , Ellis Hardwoods Ltd. UK
3. "Fundamentals of Tribology (TextBook)", By S. K. Basu, S. N.Sengupatha and D. B.Ahuja , PHI
4. "Engineering Tribology (TextBook)", By J. A. Williams , Oxford Univ. Press
5. "Tribology, Friction and Wear of Engineering Material (TextBook)", By I. M.Hutchings , Edward Arnold, London

(4)

- a. Course Name:** Computer Aided Process Planning
- b. Course Code:** 203219180
- c. Prerequisite:** A solid understanding of manufacturing processes, CAD/CAM systems, and material properties is essential, along with basic programming skills and familiarity with manufacturing systems.
- d. Rationale:** Computer Aided Process Planning enhances efficiency and accuracy in manufacturing by automating process planning, reducing lead times and costs, and ensuring flexibility and consistency across production processes.
- e. Course Learning Objective:**

CLOBJ 1	Learn the principles of Group Technology and its application in manufacturing, including the classification and coding of parts to streamline production
CLOBJ 2	Develop skills in applying computer-aided forecasting methods to predict production needs and optimize resource allocation in process planning.
CLOBJ 3	Gain a deep understanding of process engineering principles and their integration into process planning to enhance manufacturing efficiency and product quality.
CLOBJ 4	Examine various CAPP systems, understanding their architecture, functionalities, and the role they play in automating and optimizing manufacturing processes.
CLOBJ 5	Learn how to design and implement integrated process planning systems that interact seamlessly with other manufacturing systems, such as CAD, CAM, and TIPPS, to create a cohesive and efficient production environment.

f. Course Learning Outcomes:

CLO 1	Utilize Group Technology to classify and code parts, leading to more efficient and standardized manufacturing processes.
CLO 2	Use computer-aided forecasting techniques to accurately predict production demands, enabling better resource management and scheduling in process planning.
CLO 3	Create detailed and optimized process plans that align with process engineering principles, ensuring enhanced productivity and quality in manufacturing.
CLO 4	Assess and implement CAPP systems, leveraging their capabilities to automate and improve the accuracy and efficiency of process planning in a manufacturing setting.
CLO 5	Integrate process planning systems with other manufacturing systems, ensuring a seamless workflow from design to production and enhancing overall manufacturing performance.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	1	0	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	INTRODUCTION Introduction to process planning and production planning : Role of process planning in the Manufacturing cycle, Computer aided production management, Concept of route sheet, Process Planning and Concurrent Engineering	15%	7

2	COMPUTER AIDED FORECASTING Introduction to forecasting, sources of data, Demand patterns, Forecasting models, selection of forecasting technique, Computerized relative allocation of facility technique	12%	5
3	GROUP TECHNOLOGY Introduction, Part Families, Parts Classification and Coding, Design and manufacturing attributes, Features of Parts Classification and Coding Systems, Opitz, MICLASS and KK3 schemes of part classification and coding with examples, Production Flow Analysis (PFA), Machine cell design, Applications of Group Technology, Grouping of parts and machines by Rank Order Clustering (ROC)	20%	9
4	PROCESS ENGINEERING AND PROCESS PLANNING Decision table and decision trees, Process capability analysis, Process parameters, Process optimization. Process Planning, Variant process planning, and Generative approach, Forward and Backward planning, Input format, expert systems, AI, criteria for selecting CAPP system.	20%	9
5	COMPUTER AIDED PROCESS PLANNING SYSTEMS Logical Design of a Process Planning, Implementation considerations, manufacturing system components, production Volume, No. of production families, CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP, PROLOG.	13%	6
6	AN INTERGRADED PROCESS PLANNING SYSTEMS Totally integrated process planning systems (TIPPS), Design philosophy, CAD Interface, Modulus structure, Interactive surface identification, Process knowledge, Description language, Data Structure; operation - Input and Display of CAD model, surface identification, select process, select process parameters, Report Generation-Testing results, Expert process planning	20%	9

h. List of Tutorial

1.	Development of route sheets of a given product at least with five components
2	Identification of part codes using OPITZ/MICLASS/KK3 schemes of part classification and coding
3	Development of part machine incident matrix of a product

4	Use of cell formation techniques using PFA concept
5	Introduction of any of CAPP, MIPLAN, APPAS, AUTOPLAN, PROLOG software
6	Programming using any of above software
7	Demonstration of CAPP program using such software

i. Text Book and Reference Book:

1. "Industrial Robotics Technology: Programming and Applications (TextBook)", By M. P. Groover, Mitchell Weis, Roger, N. Nagel, G. Nicholas and Odrey, Tata Mc Graw-Hill, 2nd, Pub. Year 2012
2. "Principles of Process Planning (TextBook)", By G. Halevi and R.D. Weill, Chapman & Hall, Pub. Year 2008
3. An Introduction to automate process planning systems (TextBook) By Tien- Chien Chang, Richard A.Wysk, Pearson, 1st, Pub. Year 1990.

(5)

- a. Course Name:** Computer Integrated Manufacturing
- b. Course Code:** 203219181
- c. Prerequisite:** Manufacturing Processes and Production Technology
- d. Rationale:** The subject aims to developing design and manufacturing ability of equipment or assembly with manufacturing constraints, its planning and required strategy for its computer implementation. Students will learn how to simulate the real-life situations in different environments.
- e. Course Learning Objective:**

CLOBJ 1	Define key concepts in manufacturing and automation and analyze automation strategies and their practical applications in production.
CLOBJ 2	Demonstrate proficiency in the fundamental principles of CAD/CAM and analyze the product cycle and understand its integration with CAD/CAM technologies.
CLOBJ 3	Describe the evolution and types of Numerical Controls (NC) and Computer Numerical Control (CNC) systems and differentiate between various classifications of NC/CNC machines.
CLOBJ 4	Understand the foundational principles of Group Technology (GT) and apply coding systems (e.g., Opitz, MICLASS, KK3) for parts classification.
CLOBJ 5	Examine the configuration and basic motions of industrial robots and understand the technical features, programming, and end effectors of robots.

f. Course Learning Outcomes:

CLO 1	Proficiency in Automation Concepts
CLO 2	CAD/CAM Integration Skills
CLO 3	Competence in NC and CNC Programming
CLO 4	Application of Group Technology
CLO 5	Understanding and Application of Robot Technology

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	1	0	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	INTRODUCTION Fundamental concepts in Manufacturing and Automation, Automation Strategies, Economic analysis in production, fundamentals of CAD / CAM, product cycle and CAD/CAM, Automation and CAD/CAM, Scope of CIM, Automated flow lines, Transfer mechanisms, methods of Line balancing.	10%	4
2	NC AND CNC MACHINES Numerical Controls, types, evolution of controllers, components of NC/CNC system, specification of CNC system. Classification of NC /CNC machines, transducers used, salient features, Tape, Tape codes and tape readers used in the NC machines, constructional details of CNC machines, axis designation, NC/CNC tooling. Fundamentals of manual part programming, types of format, word address format manual part Programming	25%	12

	for drilling, lathe and milling machine operations, subroutines, do loops, canned Cycles, parametric sub routines. Programmable Logic Controllers (PLCs) Automated Programmed Tools language- its types of statement, command and programming.		
3	GROUP TECHNOLOGY Introduction, Part Families, Parts Classification and Coding, Design and manufacturing attributes, Features of Parts Classification and Coding Systems, Opitz, MICLASS and KK3 schemes of part classification and coding with examples, Production Flow Analysis (PFA), Machine cell design, Applications of Group Technology.	20%	10
4	FLEXIBLE MANUFACTURING SYSTEM Introduction, Need of FMS, General Considerations for FMS, components of a FMS, types of FMS, flexibilities and types, measurement techniques, Applications of FMS, workstation, planning the FMS, Automated material handling systems; types of Application, AS/RS, AGV, Manufacturing cells, concept of cellular manufacturing, group technology and just in time.	15%	6
5	ROBOT TECHNOLOGY Introduction, Industrial Robots, Robot physical Configuration, and Basic Robot motions, Robotic Power sources, Sensors, Actuators, Transducer and Grippers. Technical features, such as work volume, precision of movement speed o movement, weight carrying capacity, Programming of the robot, Introduction to robot languages, End erectors, work cell control and interlocks, Robot applications & economics, Intelligent robots interfacing of a vision system with a Robot.	20%	9
6	COMPUTER AIDED PLANNING SYSTEMS Approaches to Computer-aided Process Planning (CAPP) – Generative and Retrieval CAPP systems, benefits of CAPP, Material Requirement Planning (MRP), and mechanism of MRP, benefits, and Capacity Planning.	10%	4

i. Text Book and Reference Book:

1. "CNC Programming (TextBook)", By Dr S K Sinha
2. "Principles of Process Planning, A logical approach (TextBook)", By G. Halevi and R.D. Weill , Chapman & Hall, Pub. Year 2008

3. "An Introduction to automate process planning systems (TextBook)", By Tien-Chien Chang, Richard A.Wysk, , Pearson , 1st, Pub. Year 1990
5. Systems Approach to Computer Integrated Design and Manufacturing (TextBook) By Nanua Singh, John Wiley, Pub. Year 2008

(6)

- a. **Course Name:** Concurrent Engineering
- b. **Course Code:** 203219182
- c. **Prerequisite:** Fundamentals of Product Design and Manufacturing system
- d. **Rationale:** This course is intended to give students greater depth of technical knowledge in the areas of design concurrent engineering system for product and process in manufacturing enterprise. To enable the students to learn detailed engineering of concept and analysis of the manufacturing system and plan for project management on new product development.
- e. **Course Learning Objective:**

CLOBJ 1	Define CE and its framework, explore collaborative product development, and discuss CE design methodologies (DFMA, FMEA, etc.).
CLOBJ 2	Apply CE tools (QFD, simulation, etc.) in real-world scenarios and analyze their impact on product development and competitiveness.
CLOBJ 3	Examine life-cycle design within CE, focusing on automated analysis, real-time constraints, and optimization strategies.
CLOBJ 4	Evaluate advanced CE concepts like concurrent mechanical design, product realization taxonomy, and intelligent design systems.
CLOBJ 5	Design project plans integrating CE principles, evaluate their effectiveness, and explore case studies for insights into CE's impact on manufacturing competitiveness.

f. **Course Learning Outcomes:**

CLO 1	Define Concurrent Engineering (CE) and its framework, explaining its historical evolution and the collaborative nature of product development.
CLO 2	Demonstrate proficiency in using CE tools such as DFMA, FMEA, QFD, and simulation, showcasing their application in real-world product development scenarios.
CLO 3	Evaluate life-cycle design principles within CE, considering automated analysis, real-time constraints, and strategies for optimizing product development processes.

CLO 4	Critically analyze advanced CE concepts including concurrent mechanical design, product realization taxonomy, and intelligent design systems, understanding their role in efficient product development.
CLO 5	Design effective project plans integrating CE principles, assess their efficacy, and demonstrate an understanding of CE's impact on enhancing manufacturing competitiveness through case studies and evaluations.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	1	0	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	INTRODUCTION History of Concurrent Engineering (CE), Extensive Definition and framework of CE; collaborative product development, Implementation of CE; CE design methodologies, Organizing for CE, Role of Information technology in CE; Examples of CE applications.	14%	6
2	CE TOOLS Concurrent Engineering Tools, Design for manufacturing and assembly (DFMA), Design for quality, Design for cost, Failure Modes Effects Analysis (FMEA), Fault Tree Analysis (FTA), Design of Experiments, Taguchi's methods, Quality function deployment (QFD), Simulation, etc.	28%	13

3	DESIGN STAGE Life-cycle design of products; Modality of Concurrent Engineering Design; Automated analysis idealization control; Concurrent engineering in optimal structural design; Real-time constraints; Design for manufacturing and reliability case studies.	22%	10
4	MANUFACTURING CONCEPT AND ANALYSIS Manufacturing competitiveness; Checking the design process; conceptual design mechanism; Qualitative physical approach; An intelligent design for manufacturing system; Modeling and reasoning for computer-based assembly planning.	18%	8
5	PROJECT MANAGEMENT Life Cycle semi realization, Design for economics, Evaluation of design for manufacturing cost, Concurrent mechanical design, Decomposition in concurrent design, Product realization taxonomy, Plan for Project Management on new product development.	18%	8

i. Text Book and Reference Book:

1. "Concurrent Engineering Fundamentals: Integrated Product Development (TextBook)", By Prasad; Prentice Hall
2. "Design for Concurrent Engineering (TextBook)", By Cleetus. J; Research Centre, Morgantown, WV
3. "Concurrent Engineering: Automation Tools and Technology (TextBook)", By Andrew Kusaik; Wiley, John and Sons Inc., 1992
4. "Successful Implementation of Concurrent Product and Process (TextBook)", By Sammy G Sinha; Wiley, John and Sons Inc, 1998

(7)

- a. Course Name:** Hydraulics and Pneumatics
- b. Course Code:** 203219186
- c. Prerequisite:** Fundamentals of Control Engineering
- d. Rationale:** The course is design and formulated to impart detailed theoretical study of computational fluid dynamics and various techniques in field of fluid flow and heat transfer.

e. Course Learning Objective:

CLOBJ 1	Understand fluid power fundamentals, including components, advantages, and applications in various fields.
CLOBJ 2	Describe hydraulic cylinder classifications, directional control valves, and their operational symbols.
CLOBJ 3	Analyze pressure and flow control valves, their functions, and characteristics in fluid power systems.
CLOBJ 4	Explore advanced circuits and system design, applying calculations for hydraulic and pneumatic systems.
CLOBJ 5	Apply pneumatic control principles, design pneumatic circuits, and perform associated calculations for system design.

f. Course Learning Outcomes:

CLO 1	Demonstrate comprehension of fluid power fundamentals, component operations, and their diverse applications.
CLO 2	Identify and describe hydraulic cylinder classifications, directional control valves, and their representative symbols.
CLO 3	Analyze the functions and characteristics of pressure and flow control valves within fluid power systems.
CLO 4	Apply advanced circuit design principles and perform calculations for hydraulic and pneumatic systems.
CLO 5	Utilize pneumatic control concepts to design circuits and conduct calculations for effective system design in practical applications.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	1	0	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Fluid power fundamentals Introduction - operation principle of fluid power, definitions, units, standards and symbols, advantages and disadvantages, applications in various fields. Hydraulic cylinders: Classification and characteristics – connection types and performance parameters - differential and float concepts - typical cylinder structure - ancillary hydraulic elements	10%	6
2	Control valves Directional control valve, structure and operation of pilot-operated check valves and the directional control valves, standard symbols for representing the elements - concepts of position and way - actuation mechanisms. Pressure control valves operation - remote pressure adjustment of the pilot-operated pressure relief valve – pressure reducing valve, sequence valve, counterbalance valve, and pressure switch. Flow control valves, throttle characteristics of various orifices - flow regulating valve. Cartridge valves, proportional valves and servo valves. , etc.	45%	15
3	Hydraulic circuits Rapid motion circuits, speed control circuits, synchronous circuits, sequential circuits, counterbalance circuits and unloading circuits. Typical hydraulic system examples - movable platform system of modular machine tools - the hydraulic system of truck cranes.	15%	8
4	Pneumatic circuits Compressed air production and distribution, pneumatic control components, examples of application including electro pneumatic and hydro pneumatic controls.	15%	8

5	Design of circuits Hydraulic circuit design for typical hydraulic systems such as hydraulic press, movable platform of modular machine tools, truck cranes design calculations. Pneumatic circuit design and associated design calculations.	15%	8
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i. Text Book and Reference Book:

1. "Fluid Power Controls (TextBook)", By Pippengar, John J. and Koff, Richard M; McGraw Hill
2. "Industrial Hydraulics (TextBook)", By Pippengar, John J. and Hicks, Tyler G; Tata Mc Graw-Hill
3. "Fluid amplifiers (TextBook)", By Rao, Tewari, Kirshner, Joseph M; Tata Mc
4. Graw-Hill
5. "Design Theory of Fluidic Components (TextBook)", By Kirshner, Joseph M. and Silas Katz; Academic press.
6. "Fundamentals of Hydraulic Circuitry (TextBook)", By Dr. Heinza Zoehl. Techn; Iliffe

Semester 3

(1)

- a. **Course Name:** Operation Research
- b. **Course Code:** 203200203
- c. **Prerequisite:** Fundamental Knowledge of Mathematics
- d. **Rationale:** To impart basic knowledge to enable the student to assimilate the operations and process in the discipline of Programming, Project handling, sequencing -scheduling, queuing, networking and simulation.
- e. **Course Learning Objective:**

CLOBJ 1	To be proficient in applying dynamic programming techniques to address problems involving both discrete and continuous variables.
CLOBJ 2	To be capable of applying the concepts of non-linear programming to solve optimization problems involving functions with non-linear relationships.
CLOBJ 3	To be proficient in conducting sensitivity analysis, allowing them to assess the impact of changes in parameters on the outcomes of a decision-making or optimization model.
CLOBJ 4	The course aims to enable students to model real-world problems effectively and simulate these models, providing them with the skills to analyze and understand complex systems in practical scenarios.

f. **Course Learning Outcomes:**

CLO 1	Students should be able to apply dynamic programming to solve problems of discrete and continuous variables.
CLO 2	Students should able to apply the concept of non-linear programming
CLO 3	Students should be able to carry out sensitivity analysis.
CLO 4	Students should be able to model the real-world problem and simulate it.

g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme				
L	T	P	C	Internal Evaluation			ESE	
				MSE	CE	P	Theory	P
3	0	0	3	20	20	-	60	-
							Total	
							100	

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Topic	Weightage	Teaching Hrs.
1	Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models	18%	8
2	Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming	20%	8
3	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT	22%	8
4	Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.	20%	9
5	Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	20%	10

i. Text Book and Reference Book:

1. Operations Research by Hamdy Taha, Pearson
2. Principles of Operations Research: By Harvey M Wagner, Prentice Hall of India, Pub. Year 2010
3. Introduction to Optimization: Operations Research by J.C. Pant,, Jain Brothers
4. Operations Research by Hitler Libermann, McGraw Hill, Pub. Year 2009
5. Operations Research: by Pannerselvam, Prentice Hall of India, Pub. Year 2010

(2)**a. Course Name:** Cost Management of Engineering Projects**b. Course Code:** 203200204**c. Prerequisite:** Basic civil engineering knowledge**d. Rationale:** Project planning management and economics, cost concepts.**e. Course Learning Objective:**

CLOBJ 1	Explain the strategic cost management process and its role in organizational decision-making. Apply cost concepts such as relevant cost, differential cost, incremental cost, and opportunity cost in decision-making scenarios.
CLOBJ 2	Define the meaning and types of projects and the reasons for project management. Identify and manage cost overruns in project centers.

CLOBJ 3	Distinguish between Marginal Costing and Absorption Costing. Perform Break-even Analysis and Cost-Volume-Profit Analysis for decision-making.
CLOBJ 4	Apply quantitative techniques such as Linear Programming, PERT/CPM, transportation problems, assignment problems, and simulation in cost management.
CLOBJ 5	Explore advanced cost management techniques such as Activity-Based Cost Management, Benchmarking, Balanced Scorecard, and Value-Chain Analysis. Demonstrate an understanding of budgetary control, including flexible budgets, performance budgets, and zero-based budgets.

f. Course Learning Outcomes:

CLO 1	Understanding of the strategic cost management process and its application in decision-making.
CLO 2	Understand the significance of project management, including types of projects and the reasons for managing them.
CLO 3	Distinguish between Marginal Costing and Absorption Costing and apply them in decision-making.
CLO 4	Apply quantitative techniques, including Linear Programming, PERT/CPM, and simulation, in the context of cost management.
CLO 5	Demonstrate proficiency in advanced cost management techniques, including Activity-Based Cost Management, Benchmarking, and Balanced Scorecard.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	-	3	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Introduction Introduction and overview of strategic cost management process.	10%	4
2	Cost Concepts Cost concepts in decision making; Relevant cost, Differential cost, Incremental Cost, Opportunity cost, Objectives of costing system; Inventory valuation, Creation of database for operational control, Provision of data for decision making.	18%	4

3	Project Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception commissioning. Project execute on as conglomerate on of technical and nontechnical activities. Detailed Engineering activities. Pre-project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process	26%	13
4	Cost Behavior and Profit Planning Cost Behavior and Profit Planning Marginal Costing: Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value- Chain Analysis. Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.	26%	13
5	Quantitative techniques Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems. Assignment problems, Simulation, Learning Curve Theory.	20%	10

i. Text Book and Reference Book:

1. Cost accounting a managerial Emphasis, By Prentice Hall of India
2. Advanced Management Accounting Charles T Horngren and George Foster
3. Management and Cost Accounting Model Curriculum of Engineering and technology PG Courses Vol II] Principles and Practices of Cost Accounting, By Ashish K Bhattacharya
4. Quantitative Techniques in Management by N D Vohra, Tata McGraw-Hill

(3)

- a. **Course Name:** Composite Materials
- b. **Course Code:** 203200205
- c. **Prerequisite:** Fundamental Knowledge of Solid Mechanics
- d. **Rationale:** Composite materials are extensively used in the aviation & automobile industries for the manufacturing of various parts. Composites are known to have a high strength to weight ratio and they, therefore, become the material of choice for aircraft manufacturing. There are several other benefits of using composite materials. This subject offers the knowledge and understanding of the engineering behavior of composite materials, preliminary design concepts and their appropriate use.
- e. **Course Learning Objective:**

CLOBJ 1	Demonstrate a solid understanding of composite materials, including their introduction, key principles, and types of reinforcements.
CLOBJ 2	To describe and apply the manufacturing processes specific to metal matrix composites, and ceramic matrix composites, encompassing techniques for reinforcement incorporation and forming.
CLOBJ 3	Explain the manufacturing procedures for polymer matrix composites, covering aspects such as lay-up, curing, and post-processing steps.
CLOBJ 4	Apply knowledge of composite strength principles to analyze and predict the mechanical behavior of composite materials under different loading conditions.
CLOBJ 5	Understand the role of reinforcements in composite materials and evaluate their impact on the overall performance and properties.
CLOBJ 6	Integrate the acquired knowledge to select appropriate manufacturing processes, reinforcements, and analyze the strength of composite materials for specific engineering applications.

- f. **Course Learning Outcomes:**

CLO 1	Distinguish and categorize the types of composite materials.
CLO 2	Select reinforcements according to applications
CLO 3	Explain the fabrication techniques for PCM, MMC, CMC
CLO 4	Establish the failure criteria for laminates based on failure of individual lamina in a laminate
CLO 5	Design laminated structures subjected to in-plane and hygrothermal loads
CLO 6	Explain the need of the research in the composite materials to fulfill the demand of the hi-tech applications.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Introduction: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.	15%	7
2	Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.	25%	10
3	Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.	20%	10
4	Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.	20%	10

i. Text Book and Reference Book:

1. Materials Science and Engineering, an Introduction, William D. Callister. John Wiley and Sons Inc. Singapore.
2. Manufacturing Engineering & Technology by S. Kalpakjian, Prentice Hall.
3. Composite Materials: Science and Engineering" by Krishan K. Chawla
4. Metal Matrix Composites" by George E. Dieter
5. Composite Materials: Design and Applications" by Daniel Gay and Stephen W. Tsai
6. Handbook of Composites" by George Lubin.

(4)

- a. **Course Name:** Waste to Energy
- b. **Course Code:** 203200206
- c. **Prerequisite:** Knowledge of Renewable Energy Sources.
- d. **Rationale:** This course provides knowledge of utilization of the energy from waste and conversion of waste into Bio gas.
- e. **Course Learning Objective:**

CLOBJ 1	Understand the Principles of Waste-to-Energy Conversion
CLOBJ 2	Master the Design and Operation of Waste-to-Energy Systems
CLOBJ 3	Assess Environmental and Social Impacts of Waste-to-Energy Projects

f. Course Learning Outcomes:

CLO 1	Understand and define all the waste available and the process of turning it into energy.
CLO 2	Implement the bio mass energy in problem solving
CLO 3	Examine procedural approach for the biomass derived fuel system.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Introduction to Energy from Waste Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices -Incinerators, gasifiers, digestors	10%	4
2	Biomass Pyrolysis Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods – Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.	15%	7
3	Biomass Gasification Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.	20%	9
4	Biomass Combustion Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.	20%	8

i. Text Book and Reference Book:

1. Non-Conventional Energy (TextBook), By Desai, Ashok V., Wiley Eastern Ltd.
2. Biogas Technology - A Practical Hand Book, By Khandelwal, K. C. and Mahdi, S. S., Tata McGraw Hill Publishing Co. Ltd., Pub. Year 1983.
3. Food, Feed and Fuel from Biomass (TextBook) By Challal, D. S., IBH Publishing Co. Pvt. Ltd., Pub. Year 1991.
4. Biomass Conversion and Technology (TextBook) By C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, Pub. Year 1996.

(5)

- a. **Course Name:** Engineering Optimization
- b. **Course Code:** 203219230
- c. **Prerequisite:** Fundamental knowledge of optimization techniques.
- d. **Rationale:** The incorporation of engineering optimization is justified by providing students with a Classical Introduction to foundational concepts, fostering an understanding of the theoretical underpinnings of optimization. Through a diverse range of Optimization Techniques, the course aims to equip students with practical skills to systematically optimize machine elements. Focusing on Multivariable

Unconstrained and Constrained Optimization, the course prepares students to address complex engineering challenges.

e. Course Learning Objective:

CLOBJ 1	Demonstrate a deep understanding of engineering optimization through a Classical Introduction, grasping fundamental principles and theoretical foundations that guide the optimization process.
CLOBJ 2	Apply a diverse set of Optimization Techniques to analyze and solve engineering problems, developing the practical skills necessary for efficient and effective system optimization.
CLOBJ 3	Master the intricacies of Multivariable Unconstrained Optimization, enabling the systematic examination and enhancement of systems with multiple variables.
CLOBJ 4	Navigate the challenges of Constrained Optimization, acquiring the ability to optimize engineering systems subject to various constraints, ensuring real-world applicability.
CLOBJ 5	Apply optimization principles to achieve the Optimum Design of Machine Elements, demonstrating the capability to enhance the performance and efficiency of mechanical systems.
CLOBJ 6	Demonstrate the ability to synthesize and apply learned principles to solve real-world engineering optimization challenges.

f. Course Learning Outcomes:

CLO 1	Understand principles with a Classical Introduction to engineering optimization.
CLO 2	Apply diverse Optimization Techniques for practical problem-solving proficiency.
CLO 3	Master Multivariable Unconstrained Optimization for complex system improvement.
CLO 4	Navigate Constrained Optimization, optimizing systems under various constraints.
CLO 5	Achieve Optimum Design of Machine Elements for enhanced performance.
CLO 6	Synthesize Classical, Techniques, and Multivariable Optimization for innovative solutions.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	-	3	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Introduction Classification of optimization, design vector and constraints, constraint surface, objective function, classification of optimization problems, engineering applications of optimization.	20%	9
2	Classical Optimization Techniques Single variable optimization, multivariable optimization with no constraints, exhaustive search, Fibonacci method, golden selection, Random, pattern and gradient search methods, Interpolation methods: quadratic and cubic, direct root method.	20%	9
3	Multivariable Unconstrained and Constrained Optimization Direct search methods, descent methods, conjugate gradient method, indirect methods, Transformation techniques, penalty function method. Linear Programming: Statement of an LP problem, Simplex method, Dual simplex method.	20%	10
4	Modern Optimization Techniques Genetic Algorithms - Simulated Annealing - Tabu search methods.	17%	8
5	Optimum Design of Machine Elements Desirable and undesirable effects, functional requirement, material and geometrical parameters, design of simple axial, transverse loaded members for minimum cost and minimum weight, design of shafts, springs, Vibration absorbers	20%	9

i. Text Book and Reference Book:

1. "Engineering Optimization: Theory and Practice (TextBook)", By Singiresu S. Rao, New Age International
2. "Multi-objective optimization using evolutionary algorithms (TextBook)", By K Deb, John Wiley Publications
3. "Introduction to Optimum Design (TextBook)", By J S Arora, Mc-Graw Hill
4. "Optimization Methods for Engineering Design (TextBook)", By Fox, R.L, Wesley, Reading, Mass, Pub. Year 1971

(6)

- a. **Course Name:** Artificial Intelligence and Expert Systems in Manufacturing
- b. **Course Code:** 203219231
- c. **Prerequisite:** Zeal to learn the subject
- d. **Rationale:** The course intends to introduce concepts of artificial intelligence and its applications to mechanical engineering.
- e. **Course Learning Objective:**

CLOBJ 1	Understand and articulate the foundational principles and basic concepts of Artificial Intelligence (AI) and Expert Systems in the context of manufacturing, including key terminology, methodologies, and theoretical underpinnings.
CLOBJ 2	Identify suitable AI methods for addressing specific manufacturing problems, considering factors such as problem complexity, data availability, and computational resources, and demonstrate the ability to justify the selection.
CLOBJ 3	Formalize manufacturing problems using the language and frameworks associated with various AI methods, showcasing the capacity to translate real-world challenges into structured problems that can be addressed through AI techniques.
CLOBJ 4	Develop practical skills in implementing fundamental AI algorithms relevant to manufacturing, demonstrating proficiency in coding, debugging, and adapting algorithms to solve specific problems.
CLOBJ 5	Analyze and evaluate different AI techniques, assessing their strengths, limitations, and applicability to specific manufacturing scenarios. Demonstrate the ability to critically compare and contrast various approaches.
CLOBJ 6	Extend theoretical knowledge to practical applications by demonstrating the ability to apply AI concepts to real-life manufacturing situations. Showcase problem-solving skills through the effective integration of AI techniques.

f. Course Learning Outcomes:

CLO 1	Explain basic concept of AI and Expert system in Manufacturing
CLO 2	Identify may be suited AI method to solve a given problem which is amenable to solution
CLO 3	Formalize a given problem in the language/framework of different AI methods.
CLO 4	Implement basic AI algorithms.
CLO 5	Analyze different AI techniques to simulate it
CLO 6	Develop the concepts of AI in real life applications

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	0	3	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Basics of Artificial Intelligence History, Definition of AI, Emulation of human cognitive process, knowledge search tradeoff, stored knowledge, semantic nets. An abstract view of modeling, elementary knowledge, computational logic, analysis of compound statements using simple logic connectives, predicate logic, knowledge organization and manipulation, knowledge acquisition.	14%	6
2	Programming Introduction to LISP, syntax and numerical function, Difference between LISP and PROLOG, input output and local variables, Interaction and recursion, property list and arrays alternative languages, formalized symbolic Logics properties of WFRS, non-deductive inference methods. Inconsistencies and uncertainties: Truth	26%	12

	maintenance systems, default reasoning and closed world assumption, Model and temporary logics.		
3	Search Methods and Knowledge Representation Fuzzy logic: Concepts, Introduction to Fuzzy logic with examples, probabilistic reasoning, Bayesian probabilistic inference, Dempster Shafer theory, Ad-Hoc methods. Search and control strategies: Concepts, search problems, uniformed or Blined search, Backward and forward chaining; Hybrid contro structures; Meta rules decision lattices; Concurrency in control structures; AND-OR NOT lattices; Randomness in control structures; Grammars for interpreting languages; Rule-based system implementation-backward chaining; Virtual facts and catching; Implementation, Input/output coding, Intermediate predicates, cost and evaluation functions, Optimal path search.	26%	12
4	Knowledge Organization and Communication in Expert System Matching techniques: Need for matching, matching problem, the partial matching, Fuzzy matching, RETE matching algorithm. Knowledge organization Indexing and retrieval techniques, integration of knowledge in memory organization systems, Perception, communication and Expert systems. Overview of Linguistics, Basic passim techniques, semantic analysis and representation structures, Natural language generation and system.	20%	9
5	Expert Systems Introduction, Difference between expert system and conventional program, Basic activities of expert system, Interpretation, Prediction, Diagnosis, Design, Planning, Monitoring, Debugging, Repair, Instruction, Control, Basic aspect of expert system, Acquisition module frames, Knowledge base, Production rule, Semantic net, Inference engine, Backward chaining and forward chaining, Explanatory interface	14%	6

i. Text Book and Reference Book:

1. "Artificial Intelligence- Modern approach (TextBook)", By Russel (Stuart), Pearson
2. "Introduction to Artificial intelligence (TextBook)", By Eugene Charmian, Drew Mc Dermot , Addison Wesley Longman
3. "Artificial intelligence and the design of expert systems (Textbook)", By

4. George. F, William. A. S, The Benjamin Cummins Publishing Co., Inc
5. "Artificial intelligence An Engineering Approach (TextBook)", By Robert J Schalkoff , McGraw Hill.

(7)

- a. **Course Name:** Product Design and Development
- b. **Course Code:** 203219232
- c. **Prerequisite:** Fundamental knowledge of design principles, computer aided design and industrial engineering
- d. **Rationale:** The product development through engineering aspects is challenging especially to satisfy customized demand of end users. The aim of present course is to introduce students about stages of product design, development strategies, value engineering and modern concepts of design and manufacturing.
- e. **Course Learning Objective:**

CLOBJ 1	Understand product design, factors influencing it, and the product consumption cycle. Gain exposure to essential software tools in product design.
CLOBJ 2	Develop an understanding of the product development process, life cycle, and effective resource allocation for successful planning.
CLOBJ 3	Acquire creative thinking skills, utilize TRIZ, and navigate concept selection and testing processes in product design.
CLOBJ 4	Apply product and pricing strategies, delve into quality considerations, and explore the designer's role in addressing customer requirements and market dynamics.

- f. **Course Learning Outcomes:**

CLO 1	Explain the strategy to design and develop various products as per need of customer.
CLO 2	Summarize various attributes of product to satisfy customer's need.
CLO 3	Prepare FAST diagram and KANO model for a real product.
CLO 4	Apply the product design practices in industry.
CLO 5	Apply concept of Design for Manufacturing, Design for Assembly and Design for Environment

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	-	3	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Concept of Product Design Definition and essential factors of product design, classification and specifications of products, product life-cycle, product mix, product strategies, design by evolution, design by innovation, product policy of an organization, selection of a product based on profit considerations, standardization, product design process, product analysis, morphology of design.	15%	7
2	Customer Need and Concept Generation Customer needs and satisfaction, voice of customer, Quality Function Deployment (QFD), house of quality, introduction to Kano Diagram, organizing and prioritizing needs, affinity diagram, determining need importance, customer use patterns, customers need documentation, information gathering and its tools.	20%	9
3	Product Development Strategies Creative thinking, functional decomposition, physical decomposition, functional representation, morphological methods, TRIZ, axiomatic design, conceptual design, embodiment design, product architecture, parametric design, geometric dimensioning and tolerancing, material selection.	20%	9

4	Value Engineering Value v/s Cost, value analysis, Value Engineering Job Plan (VEJP), value engineering tools and techniques, Function cost relationship, Functional Analysis System Technique (FAST), case studies on value engineering applications in product design.	20%	9
5	Modern Concepts in Product Design and Manufacturing Role of computer in design and manufacturing, concurrent engineering, computer-aided process planning, Rapid Prototyping (RP) and its various techniques, Rapid Tooling (RT), Reverse Engineering (RE), Group Technology (GT), Cellular Manufacturing (CM), Flexible Manufacturing System (FMS), Computer Integrated Manufacturing (CIM), Design for Manufacturing (DFM), Design for Assembly (DFA), Design for Manufacturing and Assembly (DFMA), Design for Environment, ergonomic and aesthetic considerations in product design, Robust Design, Taguchi Designs, Design of Experiments, Failure Mode Effect Analysis (FMEA), Failure Mode Effect Critical Analysis (FMECA), Applications of Virtual Reality (VR), Augmented Reality (AR) and Internet of Things (IoT) in product design, development and manufacturing.	25%	11

i. Text Book and Reference Book:

1. "Product Design and Manufacturing", By A. K. Chitale, R. C. Gupta, PHI Learning Pvt. Ltd
2. "Product Design and Development (TextBook)", By Ulrich K. T, and Eppinger S.D., Tata McGraw Hill
3. "Product Design", By Kevin N. Otto, Kristin L. Wood, Pearson education, 2009
4. "Engineering Design", By George E. Dieter and Linda C. Schmidt, McGraw Hill Higher Education
5. "Value Engineering A how to Manual", By S. S. Iyer, New age International Publishers
6. "Value Engineering: A Systematic Approach (TextBook)", By Arthur E. Mudge, McGraw Hill