Naan Mudhalvan – Polytechnic – Even Semester 2024-25
4th Semester – Course Curriculum
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ABOUT THE COURSE

COURSE NAME:	Mechanical Engineering Design CAD
TOTAL DURATION:	60 HRS
MODE OF DELIVERY	PHYSICAL CLASSROOM TRAINING AT RESPECTIVE COLLEGES
TRAINER TO STUDENT RATIO:	1:60
TOTAL MARKS:	70 (External) + 30 (Internal) **(Final Assessment shall be done by TNSDC)**
TABLE 1	
OVERALL COURSE OBJECTIVE:	• Evaluate the core principles of industrial design and technology. • Develop proficiency in using Siemens NX for product design, simulation, and optimization. • Apply design principles to create functional, manufacturable, and aesthetically appealing products. • Integrate materials selection and manufacturing processes into the design workflow.
LEARNING OUTCOME:	• Apply fundamental industrial design concepts and principles. • Proficiency in using Siemens NX for 2D/3D design, modeling, and assembly. • Optimise designs for manufacturing and simulating product performance. • Analyse how materials and manufacturing processes impact design decisions. • Apply creativity and innovation in practical design challenges.

TABLE 2: MODULE-WISE COURSE CONTENT AND OUTCOME				
SL.NO	**MODULE NAME**	**MODULE CONTENT**	**MODULE LEARNING OUTCOME**	**DURATION (HRS)**
1	**Unit 1: Introduction to Industrial Design and Technology**	Overview of industrial design, importance in modern manufacturing -	• Analyse the importance and evolution of industrial design and technology.	8

		Evolution of design technologies - Introduction to Siemens NX software and its role in product design - Key principles of industrial design: ergonomics, aesthetics, functionality, and sustainability.	• Apply Siemens NX and its application in industrial design. • Recognize key design principles in industrial design.	
2	**Unit 2: Fundamentals of CAD Design with Siemens NX**	In-depth exploration of Siemens NX interface and tools - Creating 2D sketches and 3D models - Basic principles of parametric design in Siemens NX - Assembly design techniques and their applications in industrial design.	• Master Siemens NX interface and tools for industrial design. • Apply parametric design principles to create 2D and 3D models. • Implement assembly design principles for real-world applications.	15
3	**Unit 3: Product Design and Prototyping**	Introduction to prototyping processes - Designing for manufacturability: design for assembly (DFA), design for manufacturing (DFM) - Rapid prototyping techniques and their use in product design - Simulation of product performance in Siemens NX.	• Apply the concepts of product design and the importance of prototyping. • Apply DFA and DFM principles to optimize designs. • Utilize Siemens NX simulation tools to test product functionality and performance.	12
4	**Unit 4: Materials, Processes, and Manufacturing Considerations**	Overview of materials used in industrial design - Selection of materials for specific product applications - Manufacturing processes: casting, molding, machining, and additive manufacturing -	• Evaluate the role of materials in industrial design. • Select appropriate materials based on product requirements. • Incorporate manufacturing	12

		Integration of manufacturing processes into the design using Siemens NX.	processes into the design using Siemens NX.	
5	**Unit 5: Advanced Topics in Industrial Design and Technology**	Cutting-edge design trends: sustainable design, circular economy - Advanced simulation techniques in Siemens NX for stress analysis, thermal analysis, and fluid flow - Integration of CAD with CAM for efficient manufacturing - Emerging technologies in industrial design, including AI, machine learning, and IoT.	• Analyse advanced topics such as sustainable design and the circular economy. • Master advanced simulation techniques for product optimization. • Integration of CAD with CAM for seamless manufacturing.	13

TABLE 3: OVERALL COURSE LEARNING OUTCOME ASSESSMENT CRITERIA AND USECASES			
LEARNING OUTCOME	**ASSESSMENT CRITERIA**	**PERFORMANCE CRITERIA**	**USECASES**
1. Understand the Basics of Industrial Design	- Explain the principles of industrial design and its evolution.	- Demonstrate knowledge of aesthetics, form, and functionality.	1. Analyzing the evolution of industrial design in creating innovative consumer products.
	- Identify key components of industrial design (ergonomics, usability, aesthetics).	- Describe the impact of design on user experience and market success.	2. Evaluating the role of ergonomics in designing a modern office chair.
	- Explore tools and techniques used in industrial design.	- Understand the basics of CAD tools like Siemens NX.	3. Familiarizing with Siemens NX tools to create preliminary design sketches and concepts.
2. Master 3D Modeling for Product Design	- Develop 3D models of industrial	- Demonstrate proficiency in using	1. Creating a parametric 3D model for a smartphone case

	products using Siemens NX.	parametric and non-parametric modeling.	considering design flexibility.
	- Understand and apply assembly constraints in product designs.	- Effectively assemble parts with accurate constraints and motion checks.	2. Designing and assembling components for a functional mechanical tool.
3. Apply Design Thinking and Optimization	- Utilize design thinking principles to solve industrial problems.	- Develop innovative solutions with user-centered design approaches.	1. Redesigning a kitchen appliance for improved usability and efficiency.
	- Apply optimization techniques for lightweight and sustainable designs.	- Demonstrate use of tools like topology optimization for design.	2. Creating an optimized drone frame with reduced weight and improved strength.
4. Integrate Simulation into Design Validation	- Use simulation tools in Siemens NX to validate product designs.	- Analyze static, dynamic, and thermal properties of the design.	1. Performing a stress analysis on a load-bearing part of a machine.
	- Interpret simulation results to refine designs.	- Ensure the product meets safety and performance standards.	2. Validating thermal performance for an electronic device enclosure.
5. Prepare Designs for Manufacturing	- Understand and apply manufacturing constraints like draft angles and tolerances.	- Create manufacturable designs with accurate technical specifications.	1. Preparing a mold design for injection molding with proper draft angles and parting lines.
	- Ensure designs are compatible with additive and subtractive manufacturing processes.	- Demonstrate readiness for CNC machining or 3D printing.	2. Preparing a surface model for 3D printing of a prototype housing.
	- Perform manufacturability checks and adjustments.	- Identify and resolve issues in design for	3. Conducting a curvature analysis for a consumer product to

		manufacturing.	ensure smooth manufacturing.
6. Create Functional and Innovative Projects	- Design and develop a complete product using industrial design principles.	- Demonstrate creativity and technical proficiency in project execution.	1. Creating an innovative wearable device combining functionality and aesthetics.
	- Document the design and development process comprehensively.	- Present a detailed report with sketches, models, and simulations.	2. Developing a product prototype, such as a portable speaker, and documenting its design journey.
7. Explore Future Trends in Industrial Design	- Understand emerging trends like AI-driven design and sustainable product development.	- Explain the role of technology in advancing industrial design.	1. Analyzing how generative design tools are shaping the future of consumer electronics.
	- Explore the integration of augmented reality and virtual reality in product design.	- Demonstrate how these tools enhance visualization and prototyping.	2. Using AR tools to visualize and refine a furniture design before physical prototyping.
8. Develop Skills for User-Centered Design	- Conduct user research and apply findings to product development.	- Show an understanding of ergonomics and usability in product design.	1. Refining the design of a hand tool based on user feedback to improve comfort and efficiency.
	- Prototype and test designs with end-users for iterative improvements.	- Demonstrate the ability to incorporate feedback into design iterations.	2. Developing and testing a prototype for a wearable fitness tracker, iterating based on real-world user feedback.

TABLE 4: LIST OF FINAL PROJECTS (20 PROJECTS THAT COMPREHENSIVELY COVER ALL THE LEARNING OUTCOME)

SL. NO	FINAL PROJECT
1	**Custom Medical Implants**
	Task 1: Research anatomical requirements for the implant.
	Task 2: Design a patient-specific implant using CAD software.
	Task 3: Optimize the design for biocompatibility and strength.
	Task 4: Print the implant using certified biocompatible materials.
	Task 5: Test the fit and functionality in a simulated environment.

2	**Aerospace Component Design for Weight Optimization**
	Task 1: Identify a component in aerospace that requires weight optimization.
	Task 2: Redesign the component for optimal weight-to-strength ratio.
	Task 3: Model the component using CAD tools.
	Task 4: Print using lightweight aerospace-grade materials.
	Task 5: Perform strength and durability tests.
3	**Automotive Body Panel Design**
	Task 1: Design a custom body panel for a car model.
	Task 2: Create a CAD model of the panel using surface modeling techniques.
	Task 3: Optimize the design for aerodynamics and structural strength.
	Task 4: Perform testing for fit and aesthetics.
	Task 5: Prototype the body panel using rapid prototyping methods.
4	**Customized Orthopedic Braces**
	Task 1: Analyze patient-specific measurements for orthopedic support.
	Task 2: Design a customized support brace using CAD.
	Task 3: Optimize for flexibility, comfort, and durability.
	Task 4: 3D print the brace with medical-grade materials.
	Task 5: Test the fit and comfort for real-world usage.
5	**Drone Component Design for Enhanced Performance**
	Task 1: Identify components of a drone that need optimization.
	Task 2: Design lightweight and efficient drone parts such as propellers.
	Task 3: Model components in CAD software.
	Task 4: Test the components for aerodynamic efficiency in simulations.
	Task 5: Prototype the components with materials like carbon fiber.
6	**Robotic Arm Gripper Design**
	Task 1: Research the requirements for a robotic arm gripper.
	Task 2: Design an efficient and precise gripper for robotic applications.
	Task 3: Model the gripper components in CAD.
	Task 4: Print the gripper using durable materials.
	Task 5: Test the gripper’s functionality in real-world robotic scenarios.
7	**Interactive Educational Models for STEM**
	Task 1: Identify a scientific concept for an educational 3D model.
	Task 2: Design the model to showcase key concepts effectively.
	Task 3: Model it using CAD tools with intricate features.
	Task 4: Print the model using visually engaging materials.
	Task 5: Evaluate its effectiveness in classroom teaching.

8	**Wearable Health Monitoring Devices**
	Task 1: Research suitable sensors for health monitoring.
	Task 2: Design a wearable housing for sensors and electronics.
	Task 3: Model the device using CAD tools.
	Task 4: 3D print the housing using skin-safe materials.
	Task 5: Test the device for comfort, accuracy, and usability.
9	**Smart City IoT Sensor Prototypes**
	Task 1: Research smart city infrastructure requirements.
	Task 2: Design prototypes for IoT sensors or nodes.
	Task 3: Model the components in CAD software.
	Task 4: Print the components using weather-resistant materials.
	Task 5: Test the prototypes in simulated smart city environments.
10	**Energy-Efficient Turbine Blades Design**
	Task 1: Study fluid dynamics to optimize turbine blade design.
	Task 2: Design efficient turbine blades for minimal drag.
	Task 3: Model the blades in CAD software.
	Task 4: 3D print the blades using high-strength materials.
	Task 5: Test the blades in a wind tunnel for performance evaluation.
11	**Personalized Footwear Design**
	Task 1: Scan a user's foot for precise measurements.
	Task 2: Design ergonomic and custom-fit footwear.
	Task 3: Model the footwear in CAD software.
	Task 4: Print the prototype using flexible, durable materials.
	Task 5: Test the footwear for comfort and durability.
12	**Historical Artifact Replicas for Museums**
	Task 1: Analyze ancient artifacts and extract key details.
	Task 2: Create CAD models based on scans or photographs.
	Task 3: Model intricate details in CAD.
	Task 4: Print the replicas for display in museums.
	Task 5: Assess accuracy and durability of the printed replicas.
13	**Surgical Instrument Design for Precision**
	Task 1: Research and identify surgical instruments to be designed.
	Task 2: Design precise and ergonomic surgical tools.
	Task 3: Model the instrument in CAD.
	Task 4: Print using sterilizable medical-grade materials.
	Task 5: Test usability and precision in surgical simulations.
14	**Space Exploration Component Design**
	Task 1: Identify a component required for space missions.
	Task 2: Design the component for extreme conditions (thermal, mechanical).
	Task 3: Model the component in CAD software.
	Task 4: 3D print using aerospace-certified materials.
	Task 5: Test the component in vacuum and thermal environments.

15	**Electric Vehicle Component Design**
	Task 1: Research parts required for electric vehicles (e-bikes/scooters).
	Task 2: Design efficient and lightweight parts.
	Task 3: Model the parts in CAD software.
	Task 4: Print using composite materials for strength.
	Task 5: Test the components for functionality in real-world conditions.
16	**Interactive Museum Display Design**
	Task 1: Conceptualize an interactive 3D model for a museum display.
	Task 2: Design the display with interactive features (e.g., touch sensors).
	Task 3: Model using CAD for aesthetic appeal.
	Task 4: Print using durable, interactive materials.
	Task 5: Evaluate the effectiveness in engaging museum visitors.
17	**Sustainable Consumer Packaging Design**
	Task 1: Study the environmental impact of packaging.
	Task 2: Design a sustainable and functional packaging solution.
	Task 3: Model the packaging in CAD.
	Task 4: 3D print using eco-friendly materials.
	Task 5: Test its functionality and market acceptance.
18	**Marine Propulsion System Design**
	Task 1: Research marine propulsion system components (e.g., propellers, hulls).
	Task 2: Design optimized components for efficiency and durability.
	Task 3: Model the components in CAD software.
	Task 4: Print using corrosion-resistant materials.
	Task 5: Test the components in a water tank for performance.
19	**Customized Prosthetic Designs**
	Task 1: Research and identify the need for a custom prosthetic.
	Task 2: Design the prosthetic for fit and functionality.
	Task 3: Model it in CAD software.
	Task 4: 3D print the prosthetic using medical-grade materials.
	Task 5: Test it for comfort and performance.
20	**Advanced Robotics Prototype Design**
	Task 1: Research and design advanced robotic components (e.g., grippers, joints).
	Task 2: Optimize the design for movement and load-bearing capacity.
	Task 3: Model the components in CAD.
	Task 4: Print the components using strong, precision materials.
	Task 5: Test the components in real-world robotic applications.

TABLE 5: COURSE ASSESSMENT RUBRICS (TOTAL MARKS: 70)				
ASSESSMENT CRITERIA	**DESCRIBE THE CRITERIA OF THE BELOW CATEGORY PERFORMANCE**			**TOTAL MARKS**
	FAIR	**GOOD**	**EXCELLENT**	
1. Proficiency in using Siemens NX for 3D modeling of mechanical components	Basic understanding of Siemens NX with limited use of advanced features.	Proficient in 3D modeling with some minor inefficiencies in component design.	Expert-level proficiency with seamless 3D model design, showcasing advanced NX features with high accuracy.	10
2. Application of assembly design principles in Siemens NX	Models are created individually without proper consideration for assembly constraints.	Good assembly design with minor errors or misalignments in assembly constraints.	Highly efficient and optimized assembly design, ensuring correct constraints, motion simulation, and interference checks.	10
3. Use of simulation tools (static, dynamic, thermal) within Siemens NX for design validation	Basic use of simulation tools with limited results or incorrect application to designs.	Correct use of simulation tools, yielding relevant and reliable results with some minor issues in interpretation.	Advanced use of simulation tools with precise results, optimizing designs based on detailed analysis and proper interpretation.	10
4. Design optimization techniques (e.g., topology, shape, and size optimization) in Siemens NX	Limited use of optimization techniques, with a focus on basic geometric adjustments.	Effective use of optimization techniques, resulting in reduced weight and improved functionality of components.	Exceptional use of advanced optimization techniques, achieving optimal designs with superior material efficiency and performance.	10
5. Understanding and selection of manufacturing processes based on the design	Limited understanding of manufacturing processes with improper selection for	Good understanding and appropriate selection of manufacturing processes based on the	Excellent understanding of manufacturing processes, selecting and applying the most efficient processes	10

(additive, subtractive, injection molding, etc.)	specific designs.	design requirements.	for the design and material.	
6. Ability to create detailed technical drawings from 3D models in Siemens NX	Basic technical drawings with limited detail and clarity.	Detailed technical drawings with clear annotations, dimensions, and tolerances.	Exceptional technical drawings with comprehensive details, including precise annotations, section views, and bill of materials.	10
7. Creation of a functional and innovative project using Siemens NX and presenting the complete design and manufacturing process	Project is functional with limited creativity or innovation and minimal documentation.	Project is functional and innovative, with clear documentation of the design process and manufacturing steps.	Highly functional and innovative project, demonstrating excellent design thinking, complete documentation, and a well-executed final product.	10

Category	Assessment Criteria	Performance Levels	Weightage (Marks)
Practical Skills Proficiency	Demonstrates proficiency in using Siemens NX for 3D modeling of mechanical components.	Fair, Good, Excellent	10
Assembly Design	Applies proper assembly design principles in Siemens NX.	Fair, Good, Excellent	10
Simulation Tools Use	Uses static, dynamic, or thermal simulation tools in Siemens NX for design validation.	Fair, Good, Excellent	10
Design Optimization	Applies design optimization techniques (e.g., topology, shape optimization) for mechanical components.	Fair, Good, Excellent	10
Manufacturing Knowledge	Selects appropriate manufacturing processes based on the design (additive, subtractive, etc.).	Fair, Good, Excellent	10