Product Design and Manufacturing - 3D Surface Modelling (MECH)

Course Learning Objectives	• Imparts Knowledge on the role of Design Engineer in sketches. • Imparts Knowledge on the role of Mechanical Design Engineer in solid modeling. • Imparts Knowledge on design wireframes. • Imparts Knowledge on role of Assembly Designer in building assemblies. • To provide an extensive database of exercises for additional practice on advanced topics of Generative Shape Design. • To create knowledge on Industry based practices. This course is a comprehensive introduction to defining and performing additive manufacturing process simulations. • It teaches you how to add material to the part, define laser paths, and model cooling effects during the build process in the context of thermal and thermal-stress simulations.
Course Outcomes	• Design solid models using the parametric approach • Build assemblies using solid models • Generate simple mechanisms • Simulate the relative motions • Generate detailed drawings for parts and assemblies. • Generate Generative Shape Design app to create curves and surfaces. • Best innovative design will be identified and 3D printed using the Additive Manufacturing Method. • Perform additive manufacturing process simulations.

	• Students will add material to the part, define laser paths, and model cooling effects during the • Build process in the context of thermal and thermal-stress simulations.

Course Duration: 45 Hours

UNIT I CREATING SOLID COMPONENTS

Creating the Sketch Support - Creating Complex Profiles and Transforming Sketch Elements - Creating Extruded and Revolved Features - Creating Holes, Threads and Taps - Creating and Analyzing Drafts - Fillets and Chamfers - Shelling and Stiffening a Part and Creating Relations between Dimensions

UNIT II ASSEMBLY DESIGN FUNDAMENTALS

Creating and Modifying Products-Introduction to Assembly Design-Assigning or Modifying Product Properties-Inserting PLM Objects-Inserting Existing PLM Objects-Assigning Component Properties-Reordering a Product Structure-Unloading Objects from a Session-Exercise: Creating Products

UNIT III POSITIONING COMPONENTS

About Degrees of Freedom-Analyzing & Displaying Degrees of Freedom-Creating Interface- Based Connections-Engineering Connections-Fixing Components Together - Case Study - Create the Views of Industry Use Case - Create a Front View-Creating a Section View-Adda Breakout-Insert an Isometric View.

UNIT IV CREATING SURFACES

Selecting the choice of surfaces - Extruding and revolving a profile and sweeping a profile - Creating a Multi-Section and an Adaptive Sweep Surface - Case Study-Extruded surfaces creation- Creation of revolved surfaces- Selecting the input features.

UNIT V ADDITIVE MANUFACTURING PROCESS SIMULATIONS

Application Overview - Guided User Assistant Panel – Setup – Meshes - Part and Support Properties - Initial Temperatures - Moving Heat Source - Material Deposition – Cooling -Prescribed Temperatures - Structural Restraints and Loads – Procedures – Simulate – Results - Summary: Best Practices and Model Checklist -Eigenstrain Process Simulation - Residual Stresses – Eigenstrains - Basic Steps for Defining Eigenstrains - Defining a Uniform Eigenstrain in a Part - Pattern with Layer-to-Layer Rotation and Multiple Patches - Defining Two Eigenstrain Regions in a Part

Test Projects:

Industry Use Cases

1. Automotive Design:

- Develop aerodynamic surfaces for car exteriors.
- Ensure precise continuity for seamless panel integration.
- Optimize surfaces for manufacturability and cost-effectiveness.
- Create detailed 3D models for prototype testing.
- Collaborate with engineering teams for holistic vehicle design.

2. Consumer Electronics Enclosures:

- Design sleek and ergonomic surfaces for electronic devices.
- Ensure precise fits for internal components through surface modeling.
- Optimize surfaces for diverse manufacturing processes and materials.
- Conduct stress analysis to guarantee durability under various conditions.
- Generate 3D models compatible with electronic component placements.

3. Aerospace Component Optimization:

- Model aerodynamic surfaces for aircraft components.
- Optimize surfaces for weight reduction without compromising strength.
- Ensure compliance with aerospace regulations in surface design.
- Collaborate with aerodynamics engineers for performance analysis.
- Create 3D models suitable for CNC machining and composite manufacturing.

4. Medical Device Innovation:

- Design surfaces for ergonomic and user-friendly medical devices.
- Ensure compliance with medical standards and regulations.
- Optimize surfaces for easy sterilization and cleaning.
- Create detailed 3D models for prototyping and usability testing.
- Collaborate with healthcare professionals to refine designs based on user feedback.

5. Furniture Aesthetics and Functionality:

- Craft visually appealing surfaces for furniture pieces.
- Optimize surfaces for structural integrity and strength.
- Ensure ergonomic considerations for user comfort.
- Generate 3D models for virtual simulations of furniture layouts.
- Collaborate with material scientists for sustainable material choices.

6. Sports Equipment Performance Enhancement:

- Design aerodynamic surfaces for sports equipment like bicycles.
- Optimize surfaces for enhanced performance and efficiency.
- Conduct stress analysis to ensure durability under physical stress.
- Create 3D models for rapid prototyping and testing.
- Collaborate with athletes for real-world performance feedback.

7. Footwear Comfort and Style:

- Model ergonomic surfaces for comfortable shoe design.
- Optimize surfaces for different materials and manufacturing techniques.
- Ensure precise fits for various foot sizes through 3D modeling.
- Create detailed 3D prototypes for user testing.
- Collaborate with fashion designers to balance aesthetics and functionality.

8. Toy Manufacturing and Safety:

- Design visually appealing and safe surfaces for toys.
- Optimize surfaces for durability and adherence to child safety standards.
- Ensure ease of assembly during manufacturing through surface modeling.

- Generate 3D models for mass production and quality control.
- Collaborate with child development experts for age-appropriate designs.

9. Jewelry Precision and Elegance:

- Craft intricate and detailed surfaces for jewelry pieces.
- Optimize surfaces for different precious metals and gems.
- Ensure precision in surface modeling for intricate patterns.
- Generate 3D files suitable for 3D printing and casting.
- Collaborate with jewelers to balance design intricacy and production feasibility.

10. Architectural Design Elements:

- Design aesthetically pleasing surfaces for architectural elements.
- Optimize surfaces for structural integrity and durability.
- Ensure precision in surface detailing for construction.
- Create 3D models for architectural visualization and client presentations.
- Collaborate with architects to incorporate surface models into overall building designs.

11. Industrial Machinery Components:

- Model surfaces for efficient and ergonomic machine design.
- Optimize surfaces for compatibility with various manufacturing processes.
- Ensure precision in surface tolerances for seamless assembly.
- Conduct stress analysis to guarantee component durability.
- Collaborate with mechanical engineers for holistic machine integration.

12. Electrical Equipment Housing:

- Design surfaces for enclosures and housings of electrical devices.
- Ensure optimal heat dissipation through surface modeling.
- Optimize surfaces for injection molding or other manufacturing methods.
- Conduct simulations for electromagnetic compatibility.
- Generate 3D models compatible with PCB and wiring layouts.

13. Marine Equipment Design:

- Model hydrodynamic surfaces for marine vessels.
- Optimize surfaces for improved fuel efficiency and performance.
- Ensure resistance to corrosion and environmental factors.
- Create 3D models for prototyping hull designs.
- Collaborate with naval architects for comprehensive vessel integration.

14. Educational Tools Prototyping:

- Design engaging and interactive surfaces for educational tools.
- Ensure durability and safety for use in educational settings.
- Optimize surfaces for easy cleaning and maintenance.
- Create 3D models suitable for educational tool prototyping.
- Collaborate with educators for user-centric design considerations.

15. Packaging Aesthetics and Functionality:

- Craft visually appealing and functional surfaces for product packaging.
- Optimize surfaces for easy stacking and transportation.
- Ensure compatibility with printing and labeling processes.
- Create 3D models for virtual packaging simulations.
- Collaborate with packaging engineers for efficient manufacturing.

16. Robotics Component Design:

- Model surfaces for robotic components with optimal form and function.
- Ensure precision in surface tolerances for seamless movement.
- Optimize surfaces for compatibility with various materials.
- Conduct stress analysis for durability under robotic movements.
- Collaborate with robotics engineers for integrated system design.

17. Kitchen Appliance Innovation:

- Design aesthetically pleasing surfaces for kitchen appliances.
- Optimize surfaces for durability and resistance to heat and moisture.
- Ensure ease of cleaning through surface modeling.
- Generate 3D models suitable for appliance prototyping.
- Collaborate with chefs and culinary experts for user-centric design.

18. Smart Home Device Enclosures:

- Model surfaces for enclosures of smart home devices.
- Optimize surfaces for wireless signal transmission.
- Ensure compatibility with different sensor placements.
- Create 3D models suitable for 3D printing or injection molding.
- Collaborate with IoT engineers for seamless device integration.

19. Fashion Accessory Design:

- Craft stylish and unique surfaces for fashion accessories.
- Optimize surfaces for different materials and manufacturing techniques.
- Ensure comfort and wearability through surface modeling.
- Generate 3D models suitable for accessory prototyping.
- Collaborate with fashion designers to align with current trends.

20. Renewable Energy Component Design:

- Model surfaces for components in renewable energy systems.
- Optimize surfaces for durability and resistance to environmental factors.
- Ensure compatibility with sustainable materials.
-Create 3D models suitable for renewable energy component prototyping.
- Collaborate with renewable energy engineers for system integration.

Student Assessment Plan:

Each of the above-mentioned test projects will be divided into tasks by the training partner for each specific institution. Such tasks will be jointly evaluated by the faculty and the training partner and the following weightage is to be followed.

- 70% weightage to the external practical assessment.
- 30% weightage to the internal assessment.

Final Test Project/External Assessment Plan:

The Final Test Project will be chosen from the list given above, jointly by the college faculty and the Training Partner. The Final Test Project will be assessed on the following tasks, for 70%

Details	**Marks**
Task: 1	20
Task: 2	20
Task: 3	20
Task: 4	20
Task: 5	20

Employment Potential:

This course shall enable mechanical, automobile, Civil and allied domain Engineers to get employment in sectors like Manufacturing, Aerospace, Automotive, Industrial equipment manufacturing, construction and etc.