ANNEXURE I

MODULE-WISE COURSE CONTENT AND OUTCOME				
SL.NO	**MODULE NAME**	**MODULE CONTENT**	**MODULE LEARNING OUTCOME**	**DURATION (HRS)**
1	Introduction to Sheet Metal Design	- Basics and advantages of sheet metal modeling. - Overview of sheet metal design applications in engineering industries. - Introduction to parametric and non-parametric modeling approaches. - Sheet Metal Modeling vs. Solid Modeling. - Introduction to Sheet Metal Design Environment in 3DEXPERIENCE. - Material selection and its impact on sheet metal properties. - Basics of flat pattern development.	- Recognize the fundamentals and advantages of sheet metal modeling. - Differentiate between parametric and non-parametric approaches. - Correlate material selection to sheet metal properties. - Utilize basic tools and environment in 3DEXPERIENCE for flat pattern development.	8
2	Basic Sheet Metal Features	- Creating sheet metal base features: Tabs, flanges, and contour flanges. - Introduction to bends: Types, parameters, and their significance. - Creating bend features: Edge bends, jogs, and hems. - Adding holes and cutouts: Punches, corner reliefs, and cut features. - Working with bends: Bend allowance, bend deduction, and k-factor. - Creating a basic sheet metal box.	- Develop foundational sheet metal components using basic features. - Implement bends and understand their parameters. - Create openings and cutouts with precision. - Apply bending calculations for accurate modeling.	10
		- Creating lofted	- Model complex	

3	Advanced Sheet Metal Features	flanges and swept flanges. - Using bend tables for accurate modeling. - Edge treatment: Creating corners, miter flanges, and closed corners. - Using gussets and stiffeners for reinforcement. - Advanced cut features: Rip, split, and deform commands. - Exercise: Design a sheet metal enclosure with advanced features.	features like lofted and swept flanges. - Use bend tables to enhance accuracy. - Reinforce designs with gussets and stiffeners. - Implement advanced cutting features to enhance the functionality of designs.	9
4	Flattening and Unfolding	Unfolding and flattening sheet metal parts: Steps and considerations. - Understanding flat pattern: Exporting flat patterns for manufacturing. - Generating flat patterns from formed parts. - Techniques to minimize scrap material in sheet metal design. - Introduction to laser cutting and CNC compatibility considerations. - Exercise: Unfold a sheet metal part and prepare a flat pattern.	Generate accurate flat patterns from formed parts. - Prepare flat patterns suitable for manufacturing. - Reduce material waste through efficient flat pattern creation. - Adapt designs for laser cutting and CNC processes.	9
5	Quality and Design Validation	- Checking manufacturability: Identifying undercuts, sharp corners, and invalid bends. - Evaluating bend radii and corner reliefs for	- Conduct manufacturability checks on sheet metal designs. - Use design validation tools to identify and fix	9

	in Sheet Metal	manufacturability. - Use of design validation tools to check sheet metal features. - Common issues in sheet metal design and solutions. - Exercise: Validate the design of a complex sheet metal part and rectify flaws.	issues. - Analyze and improve complex designs for manufacturing standards.	

ANNEXURE II

OVERALL COURSE LEARNING OUTCOME ASSESSMENT CRITERIA AND USECASES			
LEARNING OUTCOME	**ASSESSMENT CRITERIA**	**PERFORMANCE CRITERIA**	**USE CASES**
Create and modify basic sheet metal components	- Evaluate designs using basic sheet metal features (e.g., tabs, flanges, and bends). - Assess the efficiency of flange types and bends used in the design. - Verify the accuracy of the flat pattern from 3D geometry.	- Ability to create components with the correct bend parameters, openings, and cuts. - Demonstrated skills in creating standard shapes and configurations, such as L-shaped brackets or trays. - Designs should reflect manufacturability with accurate flat patterns.	- Automotive parts like brackets and enclosures. - Consumer electronics housings such as phone cases, laptop enclosures. - Electrical enclosures in industrial settings; brackets for light fixtures.
Develop complex sheet metal components with advanced features	- Utilize advanced features like lofted flanges, gussets, and split cuts. - Evaluate the use of gussets and stiffeners for structural integrity. - Verify correct application of split cuts and swept flanges for non-linear geometries.	- Demonstrated ability to model complex geometries and apply advanced cut techniques. - Ability to integrate advanced sheet metal features into efficient designs with minimal adjustments.	- Aerospace components like fuselage skins; Heavy-duty industrial machine enclosures. - Automotive chassis reinforcement and frame structures. - Aircraft fuselage and engine parts; industrial storage cabinets.
Generate accurate flat patterns for manufacturing	- Correctly generate flat patterns based on the formed part geometry. - Ensure correct bend allowances, deductions, and k-factor applications for unfolding. - Assess	- Accuracy in generating flat patterns suitable for CNC or laser cutting. - Designs should consider material behavior during the forming process to	- HVAC ductwork, laser-cut panels, custom automotive body panels. - Appliance parts such as refrigerators or microwaves;

	compatibility of the flat pattern with common manufacturing methods, such as laser cutting or stamping.	generate accurate flat patterns. - Flat patterns should meet all manufacturing specifications and tolerances for production efficiency.	custom machine covers. - Medical device enclosures for products such as MRI scanners or ventilators.
Evaluate the manufacturability of sheet metal designs	- Check designs for manufacturability using validation tools and best practices (e.g., bend radii, undercuts). - Assess the usability of corner reliefs, bend radii, and part clearances in real-world manufacturing processes. - Identify and correct issues related to material selection that could impact manufacturability (e.g., material thinning).	- Ability to identify issues in designs that would affect manufacturability and propose solutions. - Designs should pass manufacturability checks and conform to required industry standards. - Evaluation of material performance, considering both design constraints and manufacturing requirements.	- Medical device enclosures, consumer electronics, automotive chassis. - Design validation for automotive parts, consumer electronics housings, industrial equipment. - Heavy equipment and machinery housings; aerospace components for structural integrity.
Optimize sheet metal designs for cost-effectiveness and material efficiency	- Evaluate the design for material wastage and manufacturing costs. - Analyze the material yield, scrap rate, and nesting efficiency for a given design. - Assess the impact of design changes on overall production time and material usage.	- Effectiveness in minimizing scrap material and optimizing design for cost savings. - Ability to propose design modifications that reduce material costs while maintaining functionality. - Achieve a balance between cost-efficiency and functional requirements in a design.	- Wind turbine frames, solar panel supports, and other renewable energy components. - Automotive body parts and chassis; electrical panels for construction. - Structural panels for buildings, machinery frames, or construction industry

			components.
Apply sheet metal modeling principles in a wide range of industries	- Demonstrate the ability to apply knowledge to create sheet metal components in various industrial sectors. - Evaluate the specific challenges in different industries, such as space constraints, structural requirements, and material properties.	- Show proficiency in modeling for different industries, considering unique design constraints. - Ability to adapt sheet metal modeling techniques to meet the specific needs of each industry. - Designs should integrate industry-specific material properties and standards.	- Automotive: Car body panels, Aerospace: Aircraft body parts, HVAC: Ventilation systems. - Consumer electronics enclosures. - Automotive: Exhaust systems; Aerospace: Aircraft control panels.
Perform quality checks and rectify design issues in sheet metal models	- Use tools to identify design flaws such as invalid bends or inadequate reliefs. - Evaluate the overall part integrity, including strength, durability, and weight, based on the design's sheet metal features. - Apply industry-standard validation tools (e.g., simulation) to predict how design flaws might affect production.	- Ability to correct flaws in a design and ensure compliance with manufacturing standards. - Skill in troubleshooting design issues and making corrections that lead to an optimized and manufacturable design. - Proactive identification and correction of issues prior to production, improving overall design quality.	- Design validation for automotive parts, consumer electronics housings, industrial equipment. - Medical device housings, enclosures for industrial machinery, and precision parts for consumer goods. - Aerospace parts such as turbine blades or landing gear components; industrial control panels.

LIST OF FINAL PROJECTS (PROJECTS THAT COMPREHENSIVELY COVER ALL THE LEARNING OUTCOME)	
S.No	**FINAL PROJECT**
1	**Geometry Handling**: All projects involve importing, cleaning, or simplifying CAD models. This includes removing errors, repairing geometry,

	and preparing models for sheet metal design by ensuring they are ready for the creation of sheet metal features such as tabs, bends, and holes.
2	**Sheet Metal Features**: Projects cover creating and modifying fundamental sheet metal features such as tabs, flanges, bends, holes, cutouts, and reliefs. This includes understanding and applying advanced features like lofted flanges, gussets, and stiffeners to enhance the strength and manufacturability of sheet metal parts.
3	**Material Properties & Flattening**: Each project involves selecting the appropriate material for the sheet metal part, considering its properties, and ensuring manufacturability. Projects also include flattening the sheet metal part and generating accurate flat patterns for manufacturing, while minimizing material waste.
4	**Design Validation & Optimization**: Projects incorporate design validation checks to ensure manufacturability, such as checking for undercuts, sharp corners, and incorrect bends. Optimization techniques are applied to reduce material usage, improve strength, and enhance the cost-effectiveness of the design.
5	**Real-World Application**: Projects cover a variety of industries, such as automotive, aerospace, consumer electronics, HVAC, and medical devices, ensuring that the designs are practical and meet industry standards. This includes designing parts that are optimized for real-world manufacturing techniques such as laser cutting, CNC machining, and assembly.

ANNEXURE III

COURSE ASSESSMENT RUBRICS (TOTAL MARKS: 70)				
ASSESSMENT CRITERIA	**DESCRIBE THE CRITERIA OF THE BELOW CATEGORY PERFORMANCE**			**TOTAL MARKS**
	FAIR	**GOOD**	**EXCELLENT**	**70**
1.Demonstrates proficiency in creating and modifying sheet metal components: Effectively uses sheet metal design tools such as tabs, flanges, bends, cutouts, and reliefs to create components that meet industry standards	10	15	20	20
2. Utilizes knowledge of material selection, flat pattern development, and manufacturability checks in creating realistic and optimized sheet metal parts.	7	12	15	15
3. Completes design projects with precision and creativity: Executes complex sheet metal modeling tasks, including advanced features like lofted and swept flanges, gussets, and stiffeners	20	25	25	25
4. Demonstrates effective communication of design intent and project progress: Communicates design decisions, technical challenges, and solutions clearly through reports, drawings, and presentations	5	7	10	10