

## Reverse Engineering

<b>COURSE OBJECTIVE:</b>	<ul style="list-style-type: none"><li>• Concepts of Reverse Engineering: Definition and basics of reverse engineering, Advantages and limitations of the process, Application of reverse engineering in industrial perspective.</li><li>• Fundamentals of digitization of data: Introduction to digitized data.&amp; Analysis of the digitized data and creation of curves.</li><li>• Working with cloud of points: Processing and meshing of points, Alignment of cloud of points</li><li>• Surface design: Surface creation using various approaches, creation of solids</li></ul>
<b>COURSE OUTCOME:</b>	<ul style="list-style-type: none"><li>• Exhibit the principles, concepts, and various aspects of reverse engineering, including their advantages, limitations, and applications.</li><li>• Work with digitized data &amp; scanned data, its importing and refining the mesh. Ability to generate surface network and analyze deviations.</li><li>• Working with cloud of points: To be able to work on CATIA digitized shape preparation and work on alignment of cloud of points, their processing and meshing.</li><li>• Generate surfaces using the approaches in surface creation from free shapes, mechanical shapes and creation of solids.</li></ul>

**Course Duration: 45 Hours**

## **Course Content:**

### **Unit-I – Essentials of Reverse engineering**

Concept of reverse engineering - Background and Industrial evolution of Reverse engineering- Application of Reverse engineering in modern industries- advantages and limitations of reverse engineering.

### **Unit-II – Scanning, Importing and processing digitized data**

Scanners: 3D Scanning Methods, Application and file format, Importing Scan data and refine mesh – creating curves on mesh to define surfaces – Create curves network for corresponding cell – Generate surface network – Analyse deviation and control shapes.

### **Unit – III - Creating and meshing the cloud of points**

Introduction to CATIA digitized shape preparation – Processing points – meshing points – Analysing the deviation – Alignment of cloud of points – 3D primitive recognition tool.

### **Unit – IV – Digitized shape to surface design**

Creating surfaces – Surface creation using untrim approach –Create powerfit – recognizing basic shapes surface creation from free shapes and mechanical shapes – generate surfaces by trimming and applying fillets- Analyze for deviation.

### **Unit – V – Digitized shape to surface design – part II**

Surface creation for mechanical shapes – Recognizing 3D primitives – Trimming surfaces – 3D primitive recognition using propagation mode – creating sketch from scans – create solids.

## **Test Projects:**

### **Use Cases**

#### **1. Aerospace:**

- Designing lightweight, complex geometries for aircraft components to reduce weight and enhance fuel efficiency.
- Creating optimized and custom-shaped parts for drones or satellite components.

Task 1: Designing lightweight geometries for aircraft

Task 2: Designing complex geometry for aircraft

Task 3: Creating optimized shape parts for drones

Task 4: creating satellite components

Task 5: Creating VTOL aircraft component

## **2. Automotive:**

- Manufacturing complex, high-strength automotive parts with intricate designs for improved performance and reduced weight.
- Designing prototypes and custom components for concept cars or racing vehicles.

Task 1: Design simple automotive parts

Task 2: Design complex and high strength automotive parts

Task 3: Designing prototypes for concepts cars

Task 4: Design racing car component

Task 5: Design disc brake component

## **3. Healthcare/Medical:**

- Customizing patient-specific implants, such as orthopedic implants or dental prosthetics, for better fit and functionality.
- Producing anatomical models for surgical planning or medical education purposes.

Task 1: Customizing patient-specific orthopedic implants

Task 2: Customizing dental prosthetics

Task 3: Producing anatomical models

Task 4: Customizing bones and knee joints

Task 5: Customizing jaw and custom-made prosthetic joints

## **4. Consumer Goods:**

- Designing personalized and customized products like jewelry, fashion accessories, or smartphone cases with intricate details.

Task 1: Designing personalized and customized Jewelry

Task 2: Designing fashion accessories

Task 3: Designing smartphone cases

Task 4: Designing consumer good (washing machine, fridge, oven etc.,)

Task 5: Designing consumer products water bottle

## **5. Architecture and Construction:**

- Scanning intricate and unique architectural models or prototypes for visualization and client presentations.

- Manufacturing complex and customized building components or decorative elements.

Task 1: Scanning intricate and unique architectural models

Task 2: prototypes for visualization and client presentations

Task 3: Designing of bridges various types

Task 4: Designing complex and customized building components

Task 5: Designing Decorative elements

## **6. Tooling and Manufacturing:**

- Developing specialized and optimized tooling components, jigs, or fixtures for manufacturing processes to improve efficiency and accuracy.
- Creating molds or dies with intricate designs for injection molding or casting.

Task 1: Scanning and designing optimized tooling components.

Task 2: Scanning and designing Jigs and fixtures.

Task 3: Designing of molds or dies.

Task 4: Designing injection molding components

Task 5: Designing casting components

## **7. Electronics:**

- By reverse engineering electronic devices, engineers can extract valuable information about the circuitry, components, and functionalities, allowing for improvements, repairs, or integration into newer systems.
- Using reverse engineering techniques to dissect and analyze competitor products, identifying their strengths, weaknesses, and innovations.

Task 1: By reverse engineering electronic devices.

Task 2: Scanning and designing diode.

Task 3: Designing of capacitors.

Task 4: Designing of Switches and switch boards.

Task 5: Designing of ICs and connectors

## **8. Defense and Military:**

- The insights gained from reverse engineering help military strategists and engineers to evaluate potential threats, develop countermeasures, and improve their own defense systems.

- Reverse engineering allows defense agencies to analyze and recreate obsolete components or systems, ensuring continued operational readiness and reducing dependency on external suppliers.

Task 1: By reverse engineering defense components.

Task 2: Scanning and designing any weapons

Task 3: Designing of Small-Calibre Arms.

Task 4: Designing of Bombs, Missiles, Other Explosive Devices and Related Equipment.

Task 5: Designing of Ground Vehicles & Components

### **9. Energy and Power Generation:**

- For analyzing and understanding the inner workings of power generation systems, such as turbines, generators, and control systems, engineers can identify areas for optimization and implement design improvements.
- Reverse engineering allows engineers to modernize the old systems by reverse engineering key components, integrating newer technologies, and ensuring compatibility with modern control and monitoring systems.

Task 1: By reverse engineering of turbines.

Task 2: Scanning and designing of generators.

Task 3: Designing of heat exchangers

Task 4: Designing of chimney.

Task 5: Designing of ID and FD fans

### **10. Education**

- Using Reverse engineering for educational purposes, creating models or prototypes to facilitate learning in engineering or design courses.

Task 1: Reverse engineering concepts and process

Task 2: Scanning and collect information about the product.

Task 3: Create a model or sketch

Task 4: Begin disassembly.

Task 5: Evaluate the product and reassemble

### **11. Food Industry:**

- Designing customized molds or shapes for chocolate, confectionery, or pastry decorations.

Task 1: Designing customized molds chocolates

Task 2: Designing of confectionery

Task 3: Designing of pastry decorations

Task 4: Designing of decorative food items

## **12. Marine Industry:**

- Engineers use reverse engineering techniques to analyze existing ship components, such as hulls, propellers, engines, and control systems.
- Ships and offshore structures often have complex systems and specialized components that may require replacement or refurbishment. Reverse engineering allows engineers to create detailed models and specifications of these components, even if original documentation is unavailable.

Task 1: Engineers use reverse engineering techniques of existing ship

Task 2: Scanning and collect information about hulls

Task 3: Create a model or sketch of propellers

Task 4: Designing of hull model

Task 5: Designing of steering gear and deck equipment

## **13. Art and Design:**

- Creating intricate sculptures or art installations using reverse engineering techniques.
- Designing unique and artistic home decor items or furniture pieces.

Task 1: Engineers use reverse engineering sculptures

Task 2: Scanning and Recreate sculptures

Task 3: Designing unique and artistic home decor items

Task 4: Designing unique furniture

Task 5: Designing of complex shape door design

## **14. Geological Exploration:**

- Designing prototypes for geological models or surveying tools.

Task 1: Reverse engineering of Geologist chisel tip pick

Task 2: Scanning and Recreate sculptures

Task 3: Designing crucible tongs

Task 4: Designing of graduated cylinder

Task 5: Designing of pocket stereoscope

## **15. Mining:**

- Producing custom-designed parts for mining equipment, optimizing for durability and performance.

Task 1: Reverse engineering of Bucket-wheel excavators

Task 2: Scanning and Reverse engineering Dragline excavator

Task 3: Designing of Mining Trucks

Task 4: Designing of Screw conveyor

Task 5: Designing of bucket elevator

## **16. Agriculture:**

- Creating specialized agricultural tools or equipment components tailored to specific farming needs.
- Designing prototypes for irrigation systems or greenhouse structures.

Task 1: Reverse engineering of Rotovator

Task 2: Scanning and Reverse engineering Seed drill

Task 3: Designing of trailer

Task 4: Designing of Cultivator

Task 5: Designing of Plough

## **17. Telecommunications:**

- Developing custom casings or housings for antennas or communication devices.
- Prototyping and manufacturing specialized components for satellite or telecom infrastructure.

Task 1: Designing of Omni directional antenna

Task 2: Reverse engineering of grid antenna

Task 3: Designing of Dial phone

Task 4: Designing of Satellite

Task 5: Designing of antenna TV

## **18. Robotics:**

- For making custom parts for robotic arms, joints, or end-effectors, optimizing for weight and strength.
- Designing prototypes for experimental robotic systems or mechanisms.

Task 1: Designing of automated guided vehicle

Task 2: Reverse engineering of Articulated robot

Task 3: Designing of Cobot

Task 4: Designing of Electrical Substation Inspection Robot

Task 5: Designing of Security Robots

### **19. Supply Chain and Logistics:**

- Reverse engineering plays a role in product development and innovation within the supply chain and logistics sector.
- Designing and producing customized parts for automated warehouse systems or conveyors.

Task 1: Reverse engineering role in product development

Task 2: innovation within the supply chain and logistics sector

Task 3: Designing and producing customized parts for automated warehouse

Task 4: Designing of good transport systems

Task 5: Designing of Conveyors and types

### **20. Research:**

- Reverse engineering is valuable in research for understanding and unraveling the complexities of biological, mechanical, or digital systems.
- Reverse engineering supports innovation and prototyping in research by providing a method to study and replicate existing technologies or products.

Task 1: Reverse engineering is valuable in research for understanding and unraveling the complexities of biological, mechanical

Task 2: Reverse engineering supports innovation and prototyping

Task 3: Research by providing a method to study

Task 4: Replicate existing technologies

Task 5: Replicate the existing engineering products