Autodesk Inventor: Dynamic Simulation & reverse engineering

Target Audience

This advanced training program is intended for mechanical engineers, CAD designers, and Inventor users who want to specialize in **dynamic simulation workflows and reverse engineering techniques** using Autodesk Inventor exclusively. The course is suitable for learners aiming to analyze motion systems, evaluate forces and torques, and reconstruct geometry from scan data, ensuring practical, industry-ready skills within Inventor's ecosystem.

Course Outcomes

By the end of this course, participants will be able to:

- Understand dynamic simulation fundamentals and workflow in Inventor.
- Define mechanisms and joints, and debug constraint issues.
- Apply motion drivers, loads, and actuation for realistic simulations.
- Model contact, friction, damping, and environmental effects.
- Use springs and dampers to evaluate system behavior and vibration response.
- Ensure mechanism stability by identifying redundancy and correcting constraints.
- Execute simulations with solver control and interpret numerical results.
- Validate outputs through motion graphs, force evaluation, and energy analysis.
- Apply simulation techniques to real-world mechanism scenarios.
- Perform reverse engineering workflows including scan data preparation, surface reconstruction, and solid modeling.

Course Objectives

- Provide advanced knowledge of Inventor's dynamic simulation environment.
- Train learners in mechanism modeling, joint definition, and motion setup.
- Develop proficiency in applying loads, drivers, and environmental effects.
- Enable learners to evaluate system stability, redundancy, and performance.
- Teach advanced post-processing and validation techniques for simulation results.
- Introduce reverse engineering workflows from scan data to solid reconstruction.
- Prepare participants for industry-oriented applications of simulation and reverse engineering.

Course Outline

The course comprises **40 hours** of theory and hands-on and is divided into **11 different chapters**. Each chapter will be followed by hands-on lab exercises to reinforce learning and gauge understanding of the topics covered.

Module 1: Dynamic Simulation Fundamentals

- Static vs dynamic simulation concepts
- Motion physics (force, inertia, acceleration)
- Degrees of freedom (DOF)
- Simulation environment overview
- Constraint-to-joint conversion
- Basic simulation workflow understanding

Module 2: Mechanism & Joint Definition

- Joint types (revolute, prismatic, etc.)
- DOF and mobility understanding
- Converting assembly constraints into joints
- Identifying under- and over-constrained systems
- Joint alignment and correction
- Debugging mechanism behavior

Module 3: Motion Drivers, Loads & Actuation

- Applying motion inputs (time, velocity, acceleration)
- Applying force and torque
- Motor-driven motion basics
- Gravity and external load setup
- Defining motion profiles
- Evaluating actuator behavior

Module 4: Contact, Friction & Environmental Effects

- Defining contact between components
- Collision detection basics
- Static and dynamic friction setup
- Damping effects
- Environmental constraints
- Stability considerations

Module 5: Springs, Dampers & System Behavior

- Applying linear and torsional springs
- Using dampers in motion systems
- Understanding oscillation behavior
- Basic vibration response concepts
- Energy storage and dissipation
- Evaluating system response

Module 6: Mechanism Stability & Redundancy

- Identifying redundant constraints
- Over-constrained vs under-constrained systems
- Debugging unstable simulations
- Improving simulation stability
- Best practices for mechanism setup

Module 7: Simulation Solving & Numerical Control

- Running simulations and solver basics
- Time-step control
- Understanding convergence behavior
- Identifying unstable solutions
- Improving simulation performance

Module 8: Results Interpretation & Validation

- Reading motion graphs (displacement, velocity, acceleration)
- Evaluating forces and torques
- Understanding reaction forces
- Energy and power interpretation
- Basic validation with expected behavior

Module 9: Applied Mechanism Analysis Scenarios

- Torque requirement analysis in rotating systems
- Load distribution in lifting mechanisms
- Dual actuator force balancing
- Crank-slider motion and force behavior
- Chain drive motion and tension behavior
- Cam-follower motion characteristics
- Gear interaction and torque transmission

Module 10: Reverse Engineering – Part I (Scan Data Preparation)

- Introduction to reverse engineering in Inventor
- Importing point cloud and mesh data
- Inspecting scan quality
- Mesh cleanup and noise reduction
- Aligning scan data with coordinate system
- Creating reference geometry from scan
- Preparing data for reconstruction

Module 11: Reverse Engineering – Part II (Surface & Solid Reconstruction)

- Planning reconstruction strategy
- Creating surfaces using extracted references
- Surface stitching and patching
- Converting surfaces into solid bodies
- Refining geometry for accuracy
- Basic deviation checking
- Preparing final model for downstream use