

# Connector Elements and Mechanism Analysis with Abaqus

Abaqus 2022



**3DEXPERIENCE**<sup>®</sup>

# About this Course

## Course objectives

The topics include:

- ▶ Comparison of connectors and MPCs
- ▶ Basic connector components
- ▶ Assembled kinematic connections
- ▶ Local relative displacements and rotations
- ▶ Defining stops and locks
- ▶ Defining connector friction
- ▶ Connector failure
- ▶ Actuating components of relative motion
- ▶ Sensors and actuators
- ▶ Output and postprocessing

## Targeted audience

Simulation Analysts

## Prerequisites

This course is recommended for engineers with experience using Abaqus



2 days

# Day 1

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- ▶ Lesson 1                    Mechanisms and Multibodies in Abaqus
  
- ▶ Lesson 2                    Connection Elements and Library (Part 1)
  - Workshop 1            Hinge Connection
  
- ▶ Lesson 3                    Connection Elements and Library (Part 2)
  - Workshop 2a          Analysis of a UJOINT
  - Workshop 2b          Four-Stroke Engine (Part 1)
  
- ▶ Lesson 4                    Connector Builder
  - Workshop 3a          Modeling Pliers
  - Workshop 3b          Four-Stroke Engine (Part 2)
  
- ▶ Lesson 5                    Overconstraints and Connectors
  - Workshop 4            Overconstraints: Hinge Model

## Day 2

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- ▶ Lesson 6 Connector Behavior (Part 1)
  - Workshop 5a Connector Attributes – Hinge Model
  - Workshop 5b Connector Attributes – Four-Stroke Engine Model
  
- ▶ Lesson 7 Connector Behavior (Part 2)
  - Workshop 6a Analysis of a Spot Weld
  - Workshop 6b Connector Friction
  
- ▶ Lesson 8 Rotational Connector Elements in Mechanism Analysis
  - Workshop 7 Rotational Connector Elements
  
- ▶ Lesson 9 Connector Actuation and Output
  - Workshop 8 Analysis of a Simple Four-Stroke Engine

# Additional Material

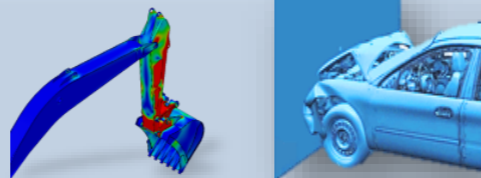
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- ▶ Appendix 1      Some Advanced Connection Types
- ▶ Appendix 2      Connector Uniaxial Behavior

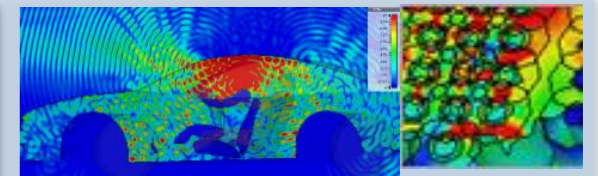
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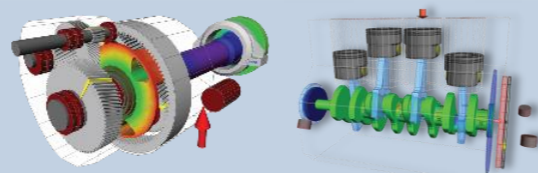
## Structures



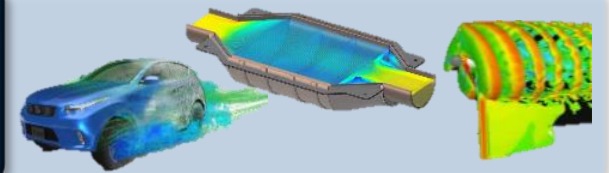
## Electromagnetics



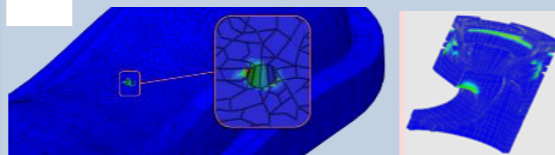
## Multibody



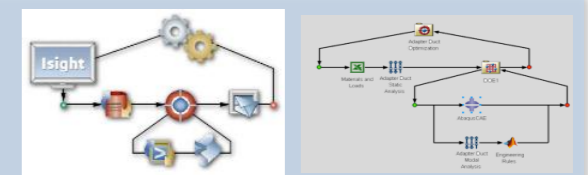
## Fluids



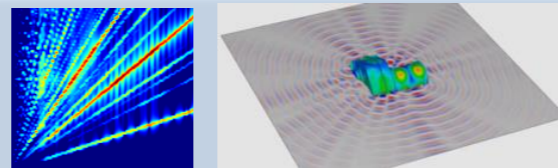
## Durability



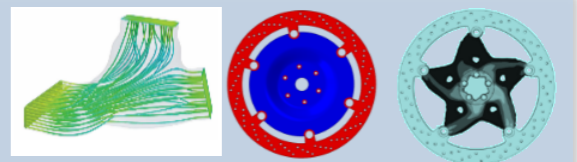
## Automation



## Vibro-acoustics



## Optimization



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# Revision Status

<b>Lesson 1</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 2</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 3</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 4</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 5</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 6</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 7</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 8</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 9</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Appendix 1</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Appendix 2</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>

<b>Workshop 1</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 2a</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 2b</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 3a</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 3b</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 4</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 5a</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 5b</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 6a</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 6b</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 7</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 8</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>

# Lesson 1: Mechanisms and Multibodies in Abaqus

## *Lesson content:*

- ▶ Introduction
- ▶ Interaction Options in Abaqus
- ▶ Connector Element Basics
- ▶ Connector Applications and Capabilities
- ▶ Connectors vs. Multi-point Constraints
- ▶ Flexible and Rigid components in a Model
- ▶ Procedures



1 hour

# Lesson 2: Connection Elements and Library (Part 1)

## *Lesson content:*

- ▶ Introduction
- ▶ Defining Connector Elements
- ▶ Understanding Connector Sections
- ▶ Understanding Connection Types
- ▶ Understanding Connector Local Directions
- ▶ Connector Element Output
- ▶ Effects of Node Ordering and Rotation on Results
- ▶ Workshop Preliminaries
- ▶ Workshop 1: Hinge Connection (IA)
- ▶ Workshop 1: Hinge Connection (KW)



Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.



1.5 hours

# Lesson 3: Connection Elements and Library (Part 2)

## *Lesson content:*

- ▶ Rotational Degrees of Freedom at Nodes
- ▶ Surface-Based Coupling Constraints
- ▶ Mesh-Independent Fasteners
- ▶ Components of Relative Motion
- ▶ Connector Local Kinematics
- ▶ Summary of Orientations and Local Directions
- ▶ Workshop 2a: Analysis of a UJOINT (IA)
- ▶ Workshop 2a: Analysis of a UJOINT (KW)
- ▶ Workshop 2b: Four-Stroke Engine (Part 1) (IA)
- ▶ Workshop 2b: Four-Stroke Engine (Part 1) (KW)



Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.



**2 hours**

# Lesson 4: Connector Builder

## *Lesson content:*

- ▶ Introduction
- ▶ Connector Builder
- ▶ Coincident Point Builder
- ▶ Workshop 3a: Modeling Pliers (IA)
- ▶ Workshop 3a: Modeling Pliers (KW)
- ▶ Workshop 3b: Four-Stroke Engine (Part 2) (IA)
- ▶ Workshop 3b: Four-Stroke Engine (Part 2) (KW)



Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.



1.5 hours

# Lesson 5: Overconstraints and Connectors

## *Lesson content:*

- ▶ General Remarks
- ▶ Overconstraints Detected during Model Processing
- ▶ Overconstraints Detected during Analysis Execution
- ▶ Controlling the Overconstraint Checks
- ▶ Example: Multibody System
- ▶ Workshop 4: Overconstraints: Hinge Model (IA)
- ▶ Workshop 4: Overconstraints: Hinge Model (KW)



Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.



1.5 hours

# Lesson 6: Connector Behavior (Part 1)

## ***Lesson content:***

- ▶ Introduction
- ▶ Defining Connector Behavior
- ▶ Connector Elasticity
- ▶ Reference Configuration for Constitutive Behavior
- ▶ Connector Damping
- ▶ Connector Stops
- ▶ Connector Locks
- ▶ Connector Failure
- ▶ Workshop 5a: Connector Attributes – Hinge Model (IA)
- ▶ Workshop 5a: Connector Attributes – Hinge Model (KW)
- ▶ Workshop 5b: Connector Attributes – Four-Stroke Engine Model (IA)
- ▶ Workshop 5b: Connector Attributes – Four-Stroke Engine Model (KW)



Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.



2 hours

# Lesson 7: Connector Behavior (Part 2)

## *Lesson content:*

- ▶ Connectors in Series/Parallel
- ▶ Connector Functions
- ▶ Connector Friction
- ▶ Connector Plasticity
- ▶ Connector Damage
- ▶ Workshop 6a: Analysis of a Spot Weld (IA)
- ▶ Workshop 6a: Analysis of a Spot Weld (KW)
- ▶ Workshop 6b: Connector Friction (IA)
- ▶ Workshop 6b: Connector Friction (KW)



Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.



2.5 hours

# Lesson 8: Rotational Connectors

## *Lesson content:*

- ▶ Cardan
- ▶ Euler
- ▶ Flexion-Torsion
- ▶ Projection Flexion-Torsion
- ▶ Rotation
- ▶ Workshop 7: Rotational Connector Elements (IA)
- ▶ Workshop 7: Rotational Connector Elements (KW)



Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.



1 hour

# Lesson 9: Connector Actuation

## *Lesson content:*

- ▶ Introduction
- ▶ Fixed Relative Motion
- ▶ Displacement-Controlled Actuation
- ▶ Force-Controlled Actuation
- ▶ Sensors and Actuators
- ▶ Workshop 8: Analysis of a Simple Four-Stroke Engine (IA)
- ▶ Workshop 8: Analysis of a Simple Four-Stroke Engine (KW)



Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.



2 hours

# Appendix 1: Some Advanced Connection Types

## *Appendix content:*

- ▶ Overview
- ▶ SLIPRING
- ▶ FLOW-CONVERTER/RETRACTOR
- ▶ Example
- ▶ Limitations



20 minutes

# Appendix 2: Connector Uniaxial Behavior

## *Appendix content:*

- ▶ Connector Uniaxial Behavior



20 minutes