Automotive NVH with Abaqus
Abaqus 2020
Course objectives
Upon completion of this course you will be able to:

- Perform natural frequency extractions
- Perform sound radiation analyses (acoustics)
- Include nonlinear preloading effects in your NVH simulations
- Perform Brake squeal analyses
- Create constraints and connections for Automotive NVH models
- Use substructuring techniques to run your NVH simulations more efficiently
- Perform advanced NVH postprocessing (via plug-ins)

Targeted audience
Simulation Analysts

Prerequisites
This course is recommended for engineers with experience using Abaqus
Day 1

- Lesson 1  Automotive NVH Overview
- Lesson 2  Modal Analysis
  - Workshop 1  Modal Analysis of a Control Arm
- Lesson 3  Steady-State Dynamics
  - Workshop 2  Steady State Dynamic Analysis of a Control Arm
- Lesson 4  Modal Transient Response
Day 2

- Lesson 5  Constraints and Interactions: Part 1
- Lesson 6  Constraints and Interactions: Part 2
  - Workshop 3  Constraints and Interactions for a Control Arm
- Lesson 7  Substructures
  - Workshop 4  Using Substructures to Model a Pick-up Truck
- Lesson 8  Base Motion Excitation
  - Workshop 5  Base Motion of a Pick-up Truck
Day 3

- Lesson 9  Coupled Structural-Acoustic Analysis
  - Workshop 6  Coupled Structural-Acoustic Analysis of a Truck
- Lesson 10  Brake Squeal Analysis
  - Workshop 7  Brake Squeal Analysis
Additional Material

- Appendix 1  Introduction to Modeling with Abaqus
- Appendix 2  Migrating from Nastran to Abaqus: Part 1
- Appendix 3  Migrating from Nastran to Abaqus: Part 2
- Workshop 8  Nastran Translation: Control Arm Model
- Appendix 4  Abaqus-EXCITE Workflow
SIMULIA is the Dassault Systèmes brand for Realistic Simulation solutions

- Portfolio of established, best-in-class products
  - Abaqus, Isight, Tosca, fe-safe, Simpack

- Design Optimization, Tosca Structure
  - Simulation-driven design refinement to improve performance

- Durability Assessment, fe-safe
  - Accurate life estimation to achieve certification

- FEA Stress Analysis, Abaqus
  - Detailed stress analysis using extracted load history from MBS

- CAD Geometry, CATIA
  - Fully parameterized 3D geometry; FEA model generation via associative interface

- Multibody Simulation, Simpack
  - System analysis to extract virtual load history of complete working cycle

- Mesh Calibration, Isight
  - Automated mesh calibration, sufficient mesh quality for accurate results

* Included in extended licensing pool
SIMULIA’s Power of the Portfolio

**Abaqus**
- Routine and Advanced Simulation
- Linear and Nonlinear, Static and Dynamic
- Thermal, Electrical, Acoustics
- Extended Physics through Co-simulation
- Model Preparation and Visualization

**Isight**
- Process Integration
- Design Optimization
- Parametric Optimization
- Six Sigma and Design of Experiments

**Tosca**
- Non-Parametric Optimization
- Structural and Fluid Flow Optimization
- Topology, Sizing, Shape, Bead Optimization

**fe-safe**
- Durability Simulation
- Low Cycle and High Cycle Fatigue
- Weld, High Temperature, Non-metallics

**Simpack**
- 3D Multibody Dynamics Simulation
- Mechanical or Mechatronic Systems
- Detailed Transient Simulation (Offline and Realtime)

**Realistic Human Simulation**
- High Speed Crash & Impact
- Noise & Vibration

**Material Calibration**
- Workflow Automation
- Design Exploration

**Conceptual/Detailed Design**
- Weight, Stiffness, Stress
- Pressure Loss Reduction

**Safety Factors**
- Creep-Fatigue Interaction
- Weld Fatigue

**Complete System Analyses**
- (Quasi-)Static, Dynamics, NVH
- Flex Bodies, Advanced Contact
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Lesson 1: Automotive NVH Overview

Lesson content:

- Introduction
- From Component to Full Vehicle NVH
- Example Analyses
- Abaqus NVH Functionality
- Summary

1 hour
Lesson content:

- Problem Formulation
- Eigenvalue Solution Methods
- Example: Engine Block Frequency Extraction
- Frequency Output
- Frequencies of Preloaded Structures
- Residual Modes
- Workshop Preliminaries
- Workshop 1: Modal Analysis of a Control Arm (IA)
- Workshop 1: Modal Analysis of a Control Arm (KW)

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

2.5 hours
Lesson 3: Steady-State Dynamics

Lesson content:

- Introduction
- Damping
- Damping Controls
- Steady-State Dynamics Solution Procedures
- Excitation and Output
- Mobility
- Steady-State Dynamics Usage Example
- Examples
- Workshop 2: Steady State Dynamic Analysis of a Control Arm (IA)
- Workshop 2: Steady State Dynamic Analysis of a Control Arm (KW)

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

2.5 hours
Lesson 4: Modal Transient Response

Lesson content:

- Introduction
- Excitation
- Output
- Examples

45 minutes
Lesson 5: Constraints and Interactions: Part 1

Lesson content:

- Introduction
- Rigid Bodies
- Surface-Based Coupling Constraints
- Surface-Based Tie Constraints
- Contact Interactions
- Automatic Contact Pair Detection
Lesson content:

- Multi-Point Constraints
- Connector Elements
- Mesh-Independent Fasteners
- Workshop 3: Constraints and Interactions for a Control Arm (IA)
- Workshop 3: Constraints and Interactions for a Control Arm (KW)

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

- Introduction
- Substructure Modeling
- Preloading Substructures
- Dynamic Substructuring
- Substructure Output
- Substructuring Example: Rolling Tires
- Workshop 4: Using Substructures to Model a Pick-up Truck (IA)
- Workshop 4: Using Substructures to Model a Pick-up Truck (KW)

Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.
Lesson 8: Base Motion Excitation

Lesson content:

- Introduction
- Primary Base Motion
- Secondary Base Motion
- Usage
- Example
- Workshop 5: Base Motion of a Pick-up Truck (IA)
- Workshop 5: Base Motion of a Pick-up Truck (KW)

Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.
Lesson 9: Coupled Structural-Acoustic Analysis

Lesson content:

- Introduction
- Coupled Structural-Acoustics Modeling
- Analysis Procedures
- Damping
- Element Size
- Acoustic Infinite Elements
- Impedance
- Output
- Acoustic Contribution Factors
- Estimate Acoustic Radiation
- Workshop 6: Coupled Structural-Acoustic Analysis of a Truck (IA)
- Workshop 6: Coupled Structural-Acoustic Analysis of a Truck (KW)

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

2.5 hours
Lesson content:

- Introduction
- Complex Eigenvalue Extraction
- Verifying Brake Squeal Simulations
- Examples
- Transient Dynamics
- References
- Workshop 7: Brake Squeal Analysis (IA)
- Workshop 7: Brake Squeal Analysis (KW)

Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.
Appendix 1: Introduction to Modeling with Abaqus

Appendix content:

- Abaqus Conventions
- Details of an Abaqus Input File
- Overview of Abaqus/CAE
- Starting Abaqus/CAE
- Orphan Mesh Import
- Example

1 hour
Appendix 2: Migrating from Nastran to Abaqus: Part 1

Appendix content:

- Introduction
- Nastran and Abaqus Input Comparison
- Translator from Nastran to Abaqus
- Solution Procedure Translation
- Validating a Translated Model

75 minutes
Appendix 3: Migrating from Nastran to Abaqus: Part 2

Appendix content:

- Modeling Differences Between Abaqus and Nastran
- Element Differences Between Abaqus and Nastran
- Interface Differences Between Abaqus and Nastran
- Translation Troubleshooting
- Workshop 8: Nastran Translation: Control Arm Model (IA)
- Workshop 8: Nastran Translation: Control Arm Model (KW)

Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.
Appendix 4: Abaqus-EXCITE Workflow

Appendix content:

- Introduction
- Abaqus-EXCITE Workflow
- Abaqus-EXCITE-Abaqus Workflow