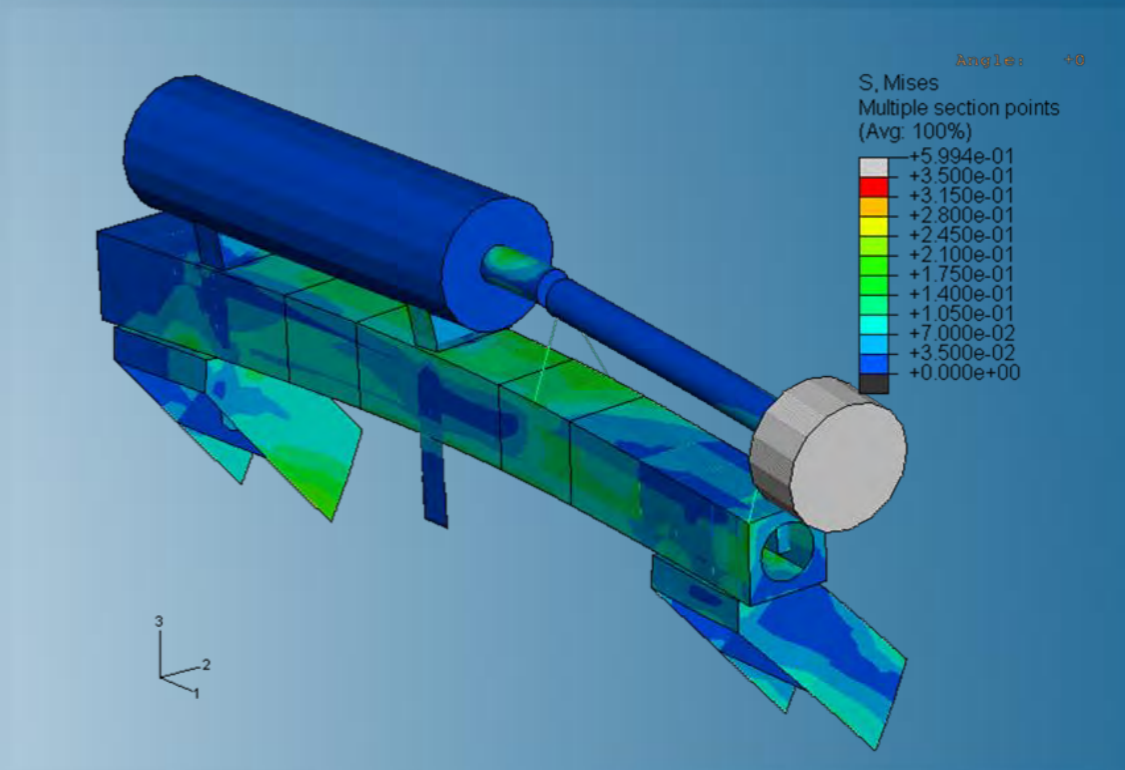


Linear Dynamics with Abaqus

2016



3DEXPERIENCE



About this Course

Course objectives

Upon completion of this course you will be able to:

- ▶ Extract eigenmodes about a certain frequency
- ▶ Determine whether the number of extracted eigenmodes is sufficient to represent the structure's response adequately
- ▶ Perform transient, steady-state, response spectrum and random response analyses using the eigenmodes
- ▶ Use multiple base motions
- ▶ Apply damping in linear problems

Targeted audience

Simulation Analysts

Prerequisites

This course is recommended for engineers with experience using Abaqus



2 days

Day 1

- ▶ Lecture 1: Introduction to Abaqus Linear Dynamics
- ▶ Lecture 2: Extracting Real Eigenvalues
 - Workshop 1: Eigenvalue Natural Frequency Extraction
- ▶ Lecture 3: Damping and Modal Superposition
- ▶ Lecture 4: Base Motion Excitation
- ▶ Lecture 5: Modal Transient Dynamics
 - Workshop 2: Modal Dynamics

Day 2

- ▶ Lecture 6: Response Spectrum Analysis
 - Workshop 3: Response Spectrum
- ▶ Lecture 7: Steady-State Harmonic Response
 - Workshop 4: Steady-State Dynamics
- ▶ Lecture 8: Introduction to Random Response
 - Workshop 5: Random Response Analysis
- ▶ Lecture 9: Complex Eigenvalue Analysis

Additional Material

- ▶ Appendix 1: Introduction to Nonlinear Dynamics
- ▶ Appendix 2: Nonlinear Dynamics: Abaqus Usage
- ▶ Appendix 3: Nonlinear Dynamics Examples

Revision Status

Lecture 1	11/15	Updated for Abaqus 2016
Lecture 2	11/15	Updated for Abaqus 2016
Lecture 3	11/15	Updated for Abaqus 2016
Lecture 4	11/15	Updated for Abaqus 2016
Lecture 5	11/15	Updated for Abaqus 2016
Lecture 6	11/15	Updated for Abaqus 2016
Lecture 7	11/15	Updated for Abaqus 2016
Lecture 8	11/15	Updated for Abaqus 2016
Lecture 9	11/15	Updated for Abaqus 2016
Appendix 1	11/15	Updated for Abaqus 2016
Appendix 2	11/15	Updated for Abaqus 2016
Appendix 3	11/15	Updated for Abaqus 2016
Workshop 1	11/15	Updated for Abaqus 2016
Workshop 2	11/15	Updated for Abaqus 2016
Workshop 3	11/15	Updated for Abaqus 2016
Workshop 4	11/15	Updated for Abaqus 2016
Workshop 5	11/15	Updated for Abaqus 2016

Lesson 1: Introduction to Abaqus Linear Dynamics

Lesson content:

- ▶ Dynamic Response
- ▶ When to Consider Dynamic Effects
- ▶ Linear Dynamics Procedures
- ▶ Linear Dynamics Software Architecture



1.5 hours

Lesson 2: Extracting Real Eigenvalues

Lesson content:

- ▶ Problem Formulation
- ▶ Eigenvalue Solution Methods
- ▶ Example: Engine Block Frequency Extraction
- ▶ Frequency Output
- ▶ Frequencies of Preloaded Structures
- ▶ Extracting Repeated Eigenfrequencies
- ▶ Residual Modes
- ▶ Workshop Model Description
- ▶ Workshop Preliminaries
- ▶ Workshop 1: Eigenvalue Natural Frequency Extraction (IA)
- ▶ Workshop 1: Eigenvalue Natural Frequency Extraction (KW)



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



3 hours

Lesson 3: Damping and Modal Superposition

Lesson content:

- ▶ Introduction
- ▶ Damping in Direct Solutions
- ▶ Damping in Modal Subspace Projection Solutions
- ▶ Damping in Modal Superposition Procedures
- ▶ Material Damping
- ▶ Element Damping
- ▶ Global Damping
- ▶ Modal Damping
- ▶ Damping Controls
- ▶ Summary



1.5 hours

Lesson 4: Base Motion Excitation

Lesson content:

- ▶ Introduction
- ▶ Primary Base Motion
- ▶ Secondary Base Motions
- ▶ Usage
- ▶ Example



45 minutes

Lesson 5: Modal Transient Dynamics

Lesson content:

- ▶ Introduction
- ▶ Excitation and Output
- ▶ Example
- ▶ Subspace Solutions for Transient Dynamics
- ▶ Workshop 2: Modal Dynamics (IA)
- ▶ Workshop 2: Modal Dynamics (KW)



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



2 hours

Lesson 6: Response Spectrum Analysis

Lesson content:

- ▶ Introduction
- ▶ The Response Spectrum
- ▶ Determining Peak Modal Response
- ▶ Modal Summation Methods
- ▶ Combining Results from Multiple Spectrums
- ▶ Spectrum Definition
- ▶ Response Spectrum Usage
- ▶ Response Spectrum Example
- ▶ Workshop 3: Response Spectrum (IA)
- ▶ Workshop 3: Response Spectrum (KW)



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



2 hours

Lesson 7: Steady-State Harmonic Response

Lesson content:

- ▶ Introduction
- ▶ Steady-State Dynamics Solution Procedures
- ▶ Excitation and Output
- ▶ Steady-State Dynamics Usage
- ▶ Comparative Example
- ▶ Workshop 4: Steady-State Dynamics (IA)
- ▶ Workshop 4: Steady-State Dynamics (KW)



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



2 hours

Lesson 8: Introduction to Random Response

Lesson content:

- ▶ Overview
- ▶ Excitation and Output
- ▶ Random Response Usage
- ▶ Base Motion Example
- ▶ Steady-State Dynamics Alternative Approach
- ▶ Workshop 5: Random Response Analysis (IA)
- ▶ Workshop 5: Random Response Analysis (KW)



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



2 hours

Lesson 9: Complex Eigenvalue Analysis

Lesson content:

- ▶ Overview
- ▶ Implementation
- ▶ Brake Squeal Analysis



75 minutes

Appendix 1: Introduction to Nonlinear Dynamics

Appendix content:

- ▶ Introduction
- ▶ Equations for Dynamic Problems
- ▶ Time integration of the equations of motion
- ▶ Automatic time incrementation
- ▶ Dynamic Contact
- ▶ Comparing Abaqus/Standard and Abaqus/Explicit



45 minutes

Appendix 2: Nonlinear Dynamics: Abaqus Usage

Appendix content:

- ▶ Implicit Dynamics
- ▶ Explicit Dynamics
- ▶ Algorithmic Details
- ▶ Initial Conditions and Loads
- ▶ Stability and Accuracy of the Trapezoidal Rule
- ▶ Material Damping
- ▶ Half-Increment Residual Tolerance



75 minutes

Appendix 3: Nonlinear Dynamics Examples

Appendix content:

- ▶ Damped shallow arch
- ▶ Ball impact
- ▶ Tennis racket and ball
- ▶ Crimp forming
- ▶ Blade containment
- ▶ Inertia relief



1 hour