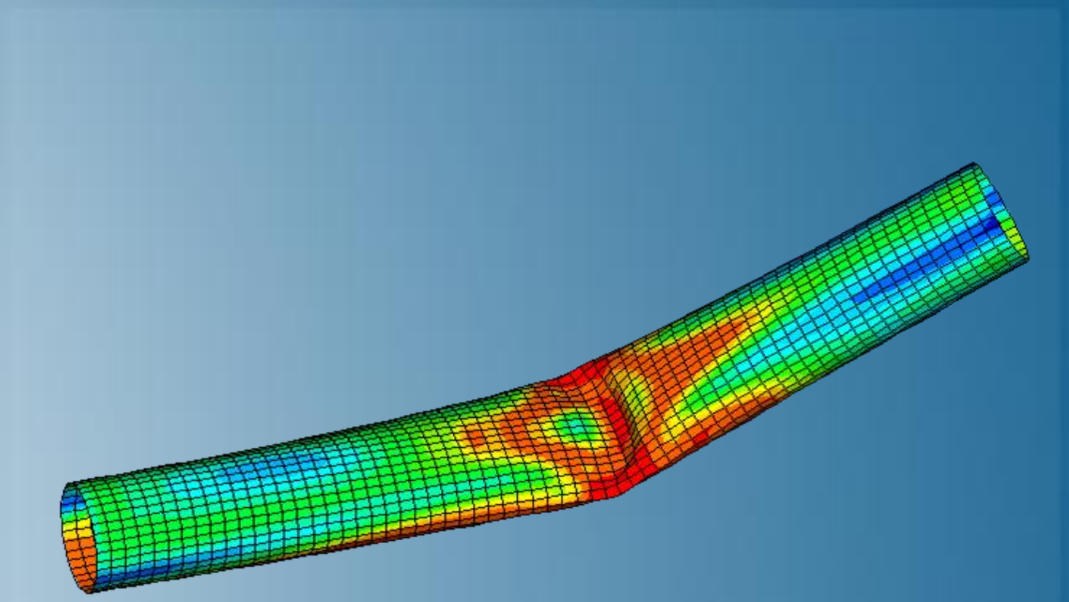
Buckling, Postbuckling, and Collapse Analysis with Abaqus

Abaqus 2018



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About this Course

Course objectives

Upon completion of this course you will be able to:

- Perform linear eigenvalue buckling analysis
- Perform postbuckling analysis using the regular and damped static solution procedures
- Perform postbuckling analysis using the modified Riks method
- Perform postbuckling analysis using dynamics solution procedures

Targeted audience

Simulation Analysts

Prerequisites

This course is recommended for engineers with experience using Abaqus

2 days

Day 1

- Lecture 1 — Basic Concepts and Overview
- Lecture 2 — Linear and Nonlinear FEA with Abaqus
- Lecture 3 — Eigenvalue Buckling Analysis
  - Workshop 1 — Elastic Buckling of a Stiffened Cylindrical Shell
  - Workshop 2 — Eigenvalue Buckling of a Ring (optional)
- Lecture 4 — Regular Static Solution Procedure
  - Workshop 3 — Nonlinear Buckling of a Stiffened Cylindrical Shell

Day 2

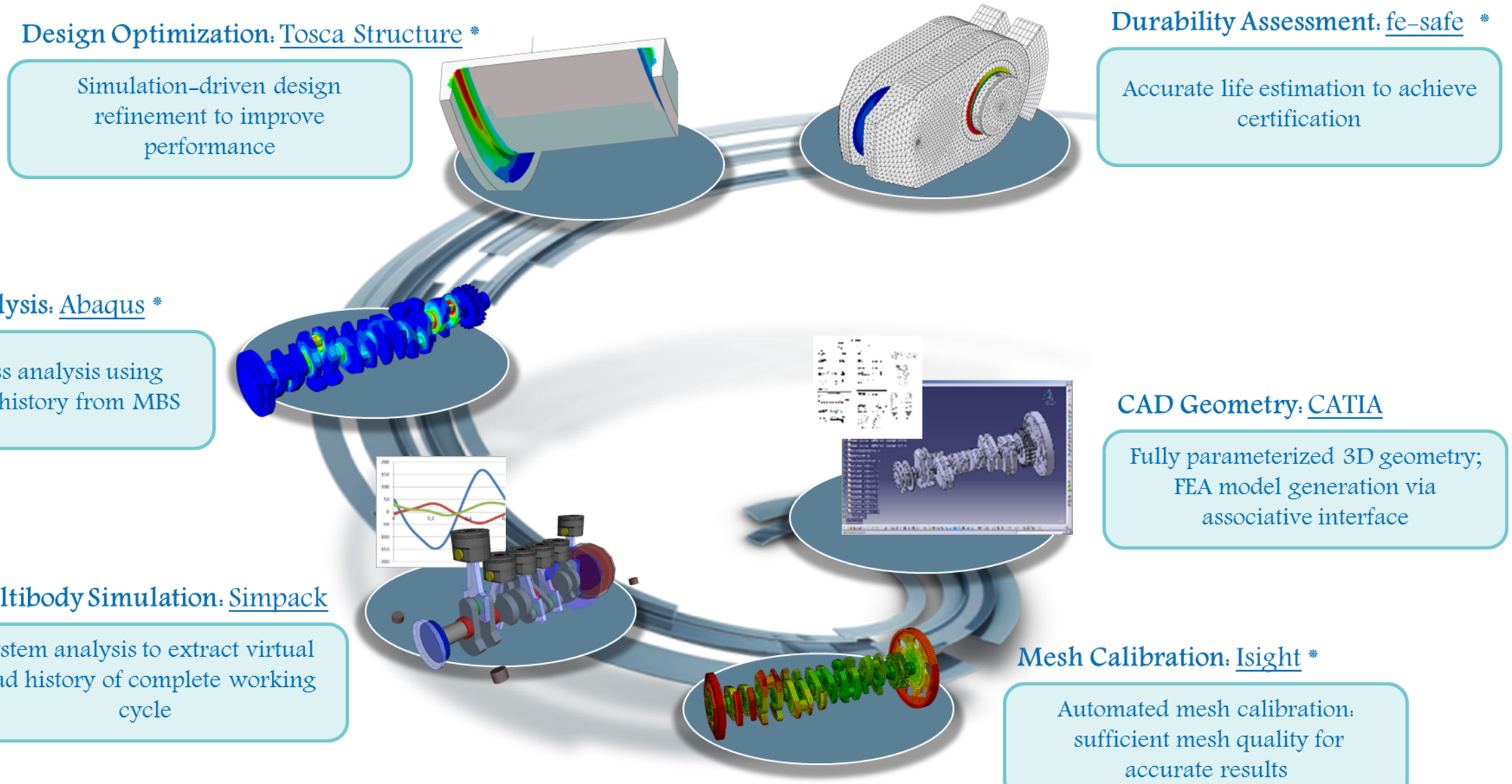
- Lecture 5 Damped Static Solution Procedure
  - Workshop 3 Nonlinear Buckling of a Stiffened Cylindrical Shell (continued)
  - Workshop 4 Static Buckling Analysis of a Circular Arch
- Lecture 6 Modified Riks Static Solution Procedure
  - Workshop 4 Static Buckling Analysis of a Circular Arch (continued)
- Lecture 7 Dynamic Analysis Solution Procedures
  - Workshop 4 Static Buckling Analysis of a Circular Arch (continued)
  - Workshop 5 Tube Crush Dynamic Analysis
- Lecture 8 Putting It All Together…
  - Workshop 6 Lee's Frame Buckling Problem
  - Workshop 7 Buckling and Postbuckling of a Crane Structure (optional)
  - Workshop 8 Buckling and Postbuckling of a Stiffened Panel (optional)

Additional Material

- Appendix 1 Geometrically Nonlinear Analysis
- Appendix 2 Dashpots

SIMULIA

- 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 *

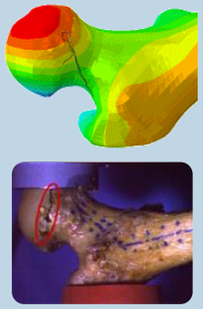
Automated mesh calibration: sufficient mesh quality for accurate results

* Included in extended licensing pool

SIMULIA's Power of the Portfolio

Abaqus

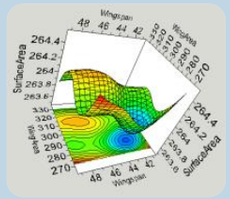
- Routine and Advanced Simulation
- Linear and Nonlinear, Static and Dynamic
- Thermal, Electrical, Acoustics
- Extended Physics through Co-simulation
- Model Preparation and Visualization



Realistic Human Simulation
High Speed Crash & Impact
Noise & Vibration

Isight

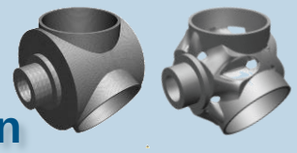
- Process Integration
- Design Optimization
- Parametric Optimization
- Six Sigma and Design of Experiments



Material Calibration
Workflow Automation
Design Exploration

Tosca

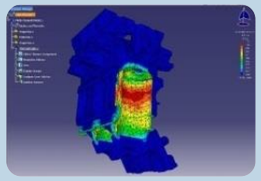
- Non-Parametric Optimization
- Structural and Fluid Flow Optimization
- Topology, Sizing, Shape, Bead Optimization



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

fe-safe

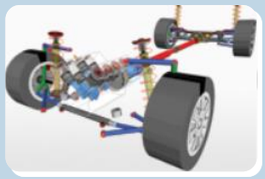
- Durability Simulation
- Low Cycle and High Cycle Fatigue
- Weld, High Temperature, Non-metallics



Safety Factors
Creep-Fatigue Interaction
Weld Fatigue

Simpack

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



Complete System Analyses
(Quasi-)Static, Dynamics, NVH
Flex Bodies, Advanced Contact

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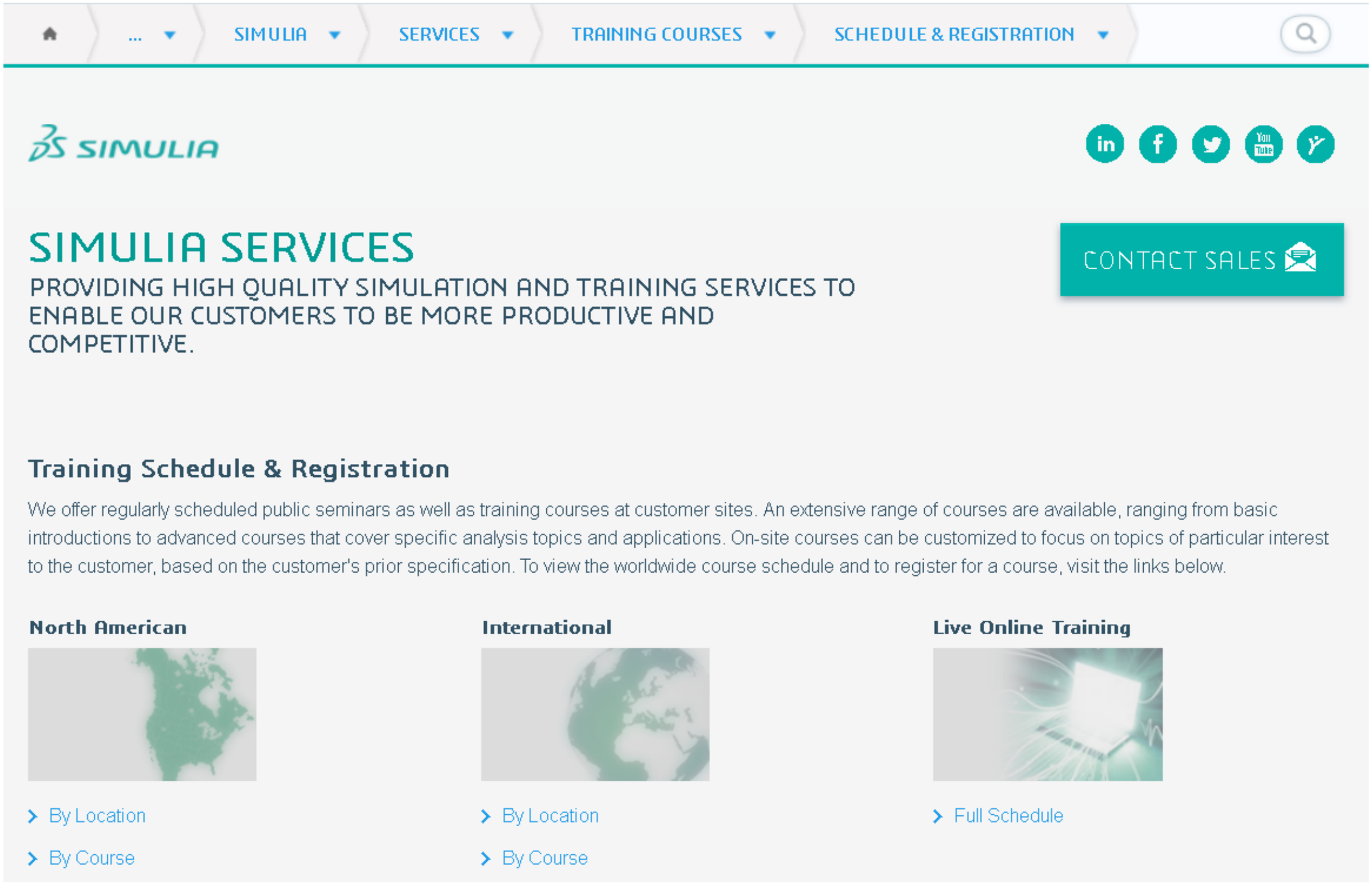

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Revision Status

Lecture 1	11/17	Updated for Abaqus 2018
Lecture 2	11/17	Updated for Abaqus 2018
Lecture 3	11/17	Updated for Abaqus 2018
Lecture 4	11/17	Updated for Abaqus 2018
Lecture 5	11/17	Updated for Abaqus 2018
Lecture 6	11/17	Updated for Abaqus 2018
Lecture 7	11/17	Updated for Abaqus 2018
Lecture 8	11/17	Updated for Abaqus 2018
Appendix 1	11/17	Updated for Abaqus 2018
Appendix 2	11/17	Updated for Abaqus 2018
Workshop 1	11/17	Updated for Abaqus 2018
Workshop 2	11/17	Updated for Abaqus 2018
Workshop 3	11/17	Updated for Abaqus 2018
Workshop 4	11/17	Updated for Abaqus 2018
Workshop 5	11/17	Updated for Abaqus 2018
Workshop 6	11/17	Updated for Abaqus 2018
Workshop 7	11/17	Updated for Abaqus 2018
Workshop 8	11/17	Updated for Abaqus 2018

Lesson 1: Basic Concepts and Overview

Lesson content:

- Introduction
- Revisiting Classical Stability Problems
- Solution Techniques
- Example: Lee’s Frame Buckling Problem
- Summary

1 hour

Lesson 2: Linear and Nonlinear FEA with Abaqus

Lesson content:

- Basic Equations in Finite Element Analysis
- Linearization
- Nonlinear Problems in Mechanics
- General and Perturbation Procedures
- Including Nonlinear Effects in an Abaqus Simulation
- Summary

1 hour

Lesson 3: Eigenvalue Buckling Analysis

Lesson content:

- Introduction
- Eigenvalue Problem Formulation
- Abaqus Usage
- Example: Buckling of a Thin Cylindrical Shell
- Closely Spaced Eigenvalues
- Boundary Conditions and Symmetry in Buckling Analyses
- Concluding Remarks
- Workshop Preliminaries
- Workshop 1: Elastic Buckling of a Stiffened Cylindrical Shell (IA)
- Workshop 1: Elastic Buckling of a Stiffened Cylindrical Shell (KW)
- Workshop 2: Eigenvalue Buckling of a Ring (IA)
- Workshop 2: Eigenvalue Buckling of a Ring (KW)

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

2 hours

Lesson 4: Regular Static Solution Procedure

Lesson content:

- Introduction
- Introducing Imperfections for Postbuckling Simulations
- Solving Nonlinear Problems with Implicit Techniques
- Solution Control
- Automatic Time Incrementation
- Diagnostic Information
- Limitations of Regular Static Procedure
- Concluding Remarks
- Workshop 3: Nonlinear Buckling of a Stiffened Cylindrical Shell (IA)
- Workshop 3: Nonlinear Buckling of a Stiffened Cylindrical Shell (KW)

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

2.5 hours

Lesson 5: Damped Static Solution Procedure

Lesson content:

- Introduction
- Damping in Static Analyses
- Automatic Stabilization
- Automatic Stabilization Examples
- Postbuckling and Loss of Contact
- Concluding Remarks
- Workshop 3: Nonlinear Buckling of a Stiffened Cylindrical Shell (IA, cont'd)
- Workshop 3: Nonlinear Buckling of a Stiffened Cylindrical Shell (KW, cont'd)
- Workshop 4: Static Buckling Analysis of a Circular Arch (IA)
- Workshop 4: Static Buckling Analysis of a Circular Arch (KW)

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

2 hours

Lesson 6: Modified Riks Static Solution Procedure

Lesson content:

- Introduction
- Abaqus Implementation
- Abaqus Usage
- Snap-Through Problems
- Postbuckling Problems
- Postbuckling Examples
- Usage Tips
- Limitations
- Concluding Remarks
- Workshop 4 (continued): Static Buckling Analysis of a Circular Arch (IA)
- Workshop 4 (continued): Static Buckling Analysis of a Circular Arch (KW)

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

1.5 hours

Lesson 7: Dynamic Analysis Solution Procedures

Lesson content:

- Overview
- What Makes a Problem Dynamic?
- Equations for Dynamic Problems
- Nonlinear Dynamics
- Comparing Abaqus/Standard and Abaqus/Explicit
- Workshop 4 (continued): Static Buckling Analysis of a Circular Arch (IA)
- Workshop 4 (continued): Static Buckling Analysis of a Circular Arch (KW)
- Analyzing Highly Nonlinear Quasi-Static Problems
- Quasi-Static Simulations Using Explicit Dynamics
- Example: Dynamic Tube Collapse
- Concluding Remarks
- Workshop 5: Tube Crush Dynamic Analysis (IA)
- Workshop 5: Tube Crush Dynamic Analysis (KW)

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

2.5 hours

Lesson 8: Putting It All Together…

Lesson content:

- Buckling Analysis Selection Guide
- Weatherseal Example
- References for Further Study
- Workshop 6: Lee's Frame Buckling Problem (IA)
- Workshop 6: Lee's Frame Buckling Problem (KW)
- Workshop 7: Buckling and Postbuckling of a Crane Structure (IA)
- Workshop 7: Buckling and Postbuckling of a Crane Structure (KW)
- Workshop 8: Buckling and Postbuckling of a Stiffened Panel (IA)
- Workshop 8: Buckling and Postbuckling of a Stiffened Panel (KW)

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

1.5 hours

Appendix 1: Geometrically Nonlinear Analysis

Appendix content:

- Introduction
- Equilibrium and Virtual Work
- Deformation and Strain
- Large Rotations
- Follower Forces

30 minutes

Appendix 2: Dashpots

Appendix content:

- Dashpots

15 minutes