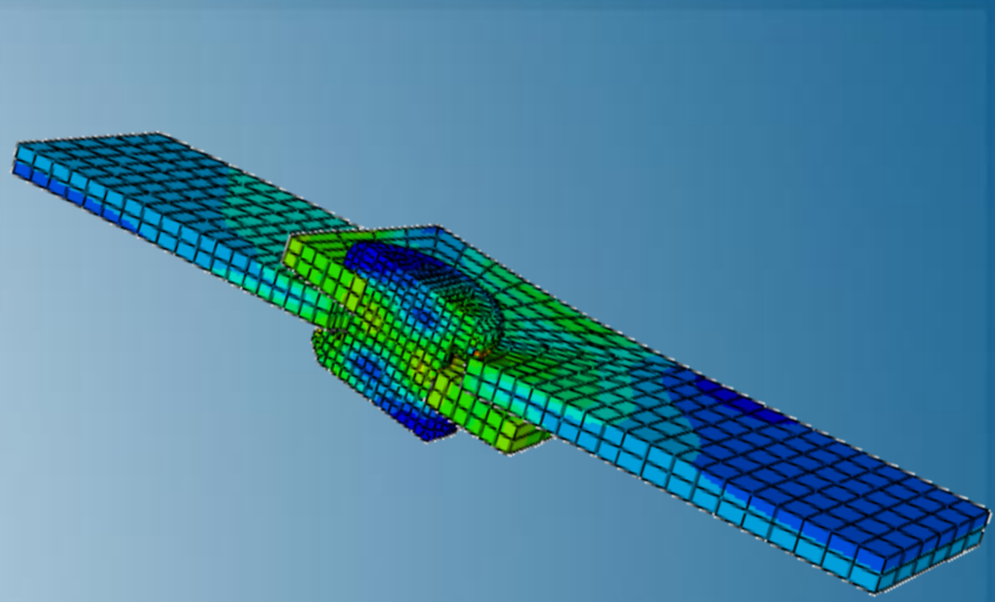
# Modeling Contact with Abaqus/Standard

## Abaqus 2018



# About this Course

## Course objectives

Upon completion of this course you will be able to:

- Define general contact and contact pairs
- Define appropriate surfaces (rigid or deformable)
- Model frictional contact
- Model large sliding between deformable bodies
- Resolve overclosures in interference fit problems

## Targeted audience

Simulation Analysts

## Prerequisites

This course is recommended for engineers with experience using Abaqus/Standard

**2 days**

# Day 1

- Lecture 1 — Introduction
- Lecture 2 — Contact Workflow
  - Workshop 1 — Compression of a Rubber Seal
- Lecture 3 — Surface-based Contact
  - Workshop 2 — Lap Joint Analysis
- Lecture 4 — Contact Logic and Diagnostics Tools
  - Workshop 3 — Bolted Flange Analysis

# Day 2

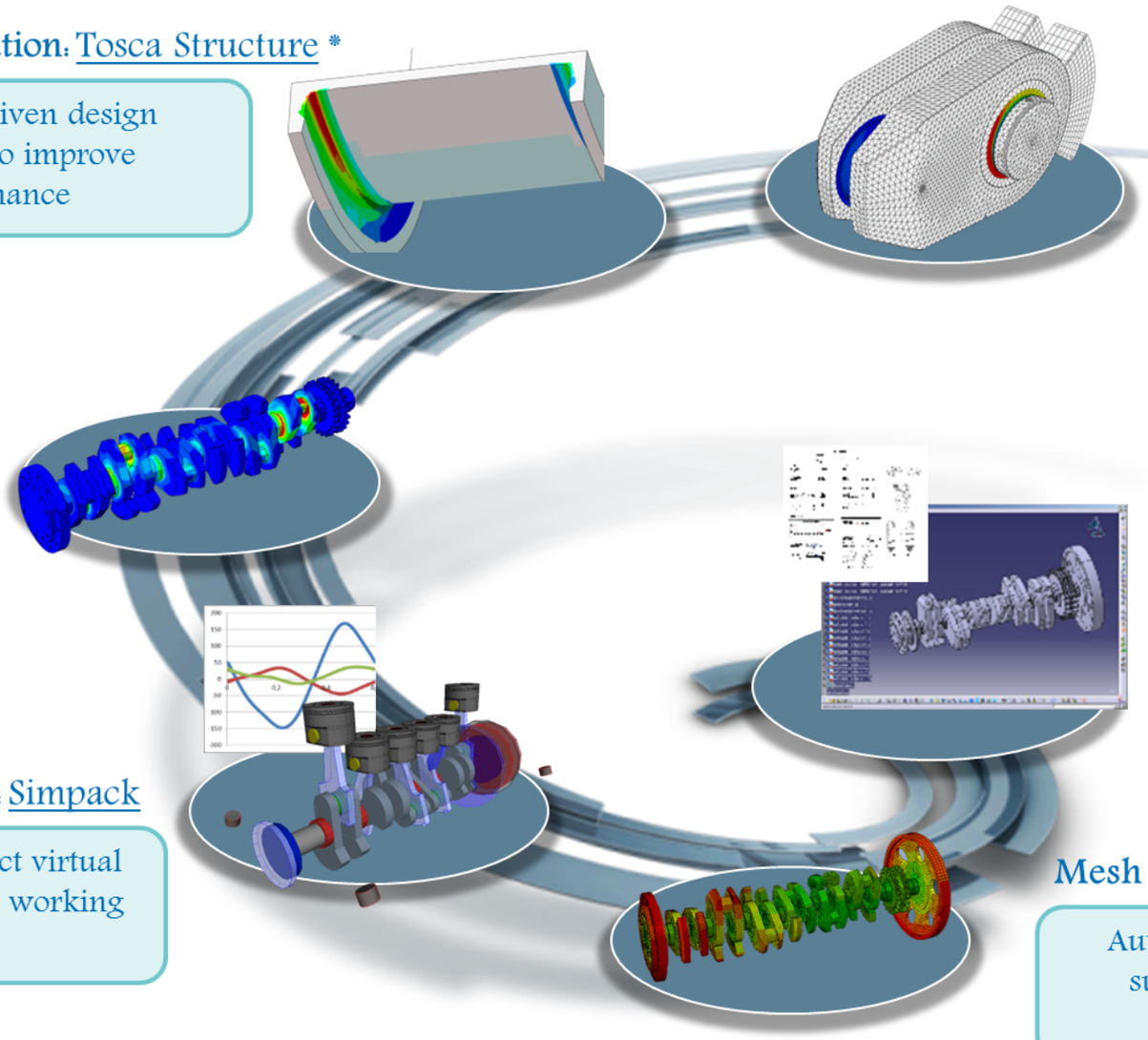
- Lecture 5 Contact Properties
  - Workshop 4 Disk Forging Analysis
- Lecture 6 Interference Fits
  - Workshop 5 Interference Fit Analysis
  - Workshop 6 Syringe Analysis (optional)
- Lecture 7 Additional Features
  - Workshop 7 Pipe Reel Analysis
- Lecture 8 Modeling Tips
  - Workshop 8 Bolted Flange Analysis: Infinitesimal Sliding
  - Workshop 9 Snap Fit Analysis
  - Workshop 10 Analysis of a Radial Shaft Seal (optional)

# Additional Material

- Appendix 1 Node-to-Surface Formulation
- Appendix 2 Contact Elements
- Appendix 3 Dynamic Contact using Implicit Integration

# 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 ***

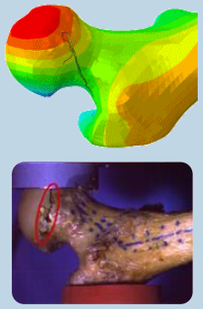
Automated mesh calibration: sufficient mesh quality for accurate results

* Included in extended licensing pool

# SIMULIA's Power of the Portfolio

**Abaqus**

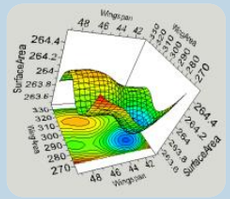
- Routine and Advanced Simulation
- Linear and Nonlinear, Static and Dynamic
- Thermal, Electrical, Acoustics
- Extended Physics through Co-simulation
- Model Preparation and Visualization



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

**Isight**

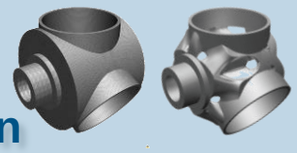
- Process Integration
- Design Optimization
- Parametric Optimization
- Six Sigma and Design of Experiments



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

**Tosca**

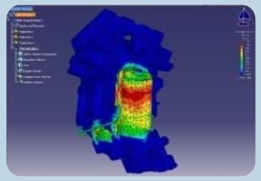
- Non-Parametric Optimization
- Structural and Fluid Flow Optimization
- Topology, Sizing, Shape, Bead Optimization



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

**fe-safe**

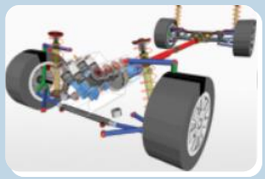
- Durability Simulation
- Low Cycle and High Cycle Fatigue
- Weld, High Temperature, Non-metallics



**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**

# Join the Community!

**How can you maximize the robust technology of the SIMULIA Portfolio ?**

Connect with peers to share knowledge and get technical insights

Go to www.3ds.com/slc
to log in or join!

SIMULIA

**Let the SIMULIA Learning Community be *Your* Portal to 21st Century Innovation**

Discover new ways to explore how to leverage realistic simulation to drive product innovation. Join the thousands of Abaqus and Isight users who are already gaining valuable knowledge from the SIMULIA Learning Community.

For more information and registration, visit **3ds.com/simulia-learning**.
**Connect. Share. Spark Innovation.**

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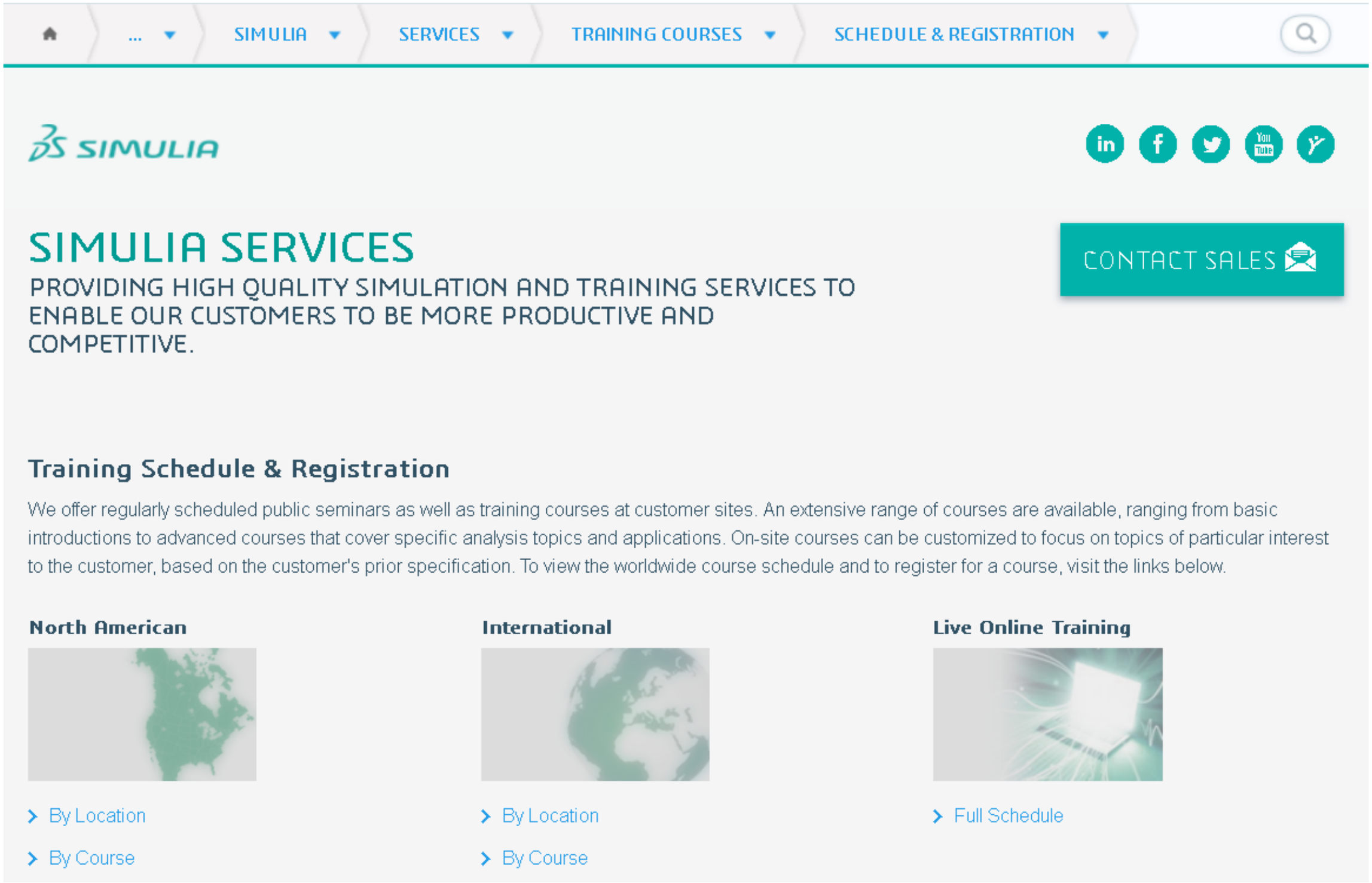
# SIMULIA Training

http://www.3ds.com/products-services/simulia/services/training-courses/



# Legal Notices

# 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 |
| Appendix 3 | 11/17 | Updated for Abaqus 2018 |

| | | |
|---|---|---|
| Workshop 1 | 11/17 | Updated for Abaqus 2018 |
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| Workshop 6 | 11/17 | Updated for Abaqus 2018 |
| Workshop 7 | 11/17 | Updated for Abaqus 2018 |
| Workshop 8 | 11/17 | Updated for Abaqus 2018 |
| Workshop 9 | 11/17 | Updated for Abaqus 2018 |
| Workshop 10 | 11/17 | Updated for Abaqus 2018 |

# Lesson 1: Introduction

***Lesson content:***

- General Considerations
- Surface-based Contact
- Contact Examples
- Ingredients of a Contact Model



**30 minutes**

# Lesson 2: Contact Workflow

***Lesson content:***

- Defining General Contact
- Defining Contact Pairs
- Defining Surfaces for Contact Pairs
- Workshop Preliminaries
- Workshop 1: Compression of a Rubber Seal (IA)
- Workshop 1: Compression of a Rubber Seal (KW)

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

**1.5 hours**

# Lesson 3: Surface-based Contact

***Lesson content:***

- Contact Formulations
- Contact Discretization
- Contact Enforcement Methods
- Relative Sliding Between Bodies
- Contact Output
- Summary
- Workshop 2: Lap Joint Analysis (IA)
- Workshop 2: Lap Joint Analysis (KW)

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

**2 hours**

# Lesson 4: Contact Logic and Diagnostics Tools

***Lesson content:***

- Newton Method
- The Contact Algorithm
- Contact Diagnostics: Visual
- Contact Diagnostics: Text
- Workshop 3: Bolted Flange Analysis (IA)
- Workshop 3: Bolted Flange Analysis (KW)

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

**2 hours**

# Lesson 5: Contact Properties

***Lesson content:***

- Pressure-Overclosure Models
- Friction Models
- Friction Enforcement
- Workshop 4: Disk Forging Analysis (IA)
- Workshop 4: Disk Forging Analysis (KW)

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

**2 hours**

# Lesson 6: Interference Fits

***Lesson content:***

- Initial Overclosure
- Strain-free Adjustments
- Interference Fit Problems
- Interference Fit Techniques for General Contact
- Interference Fit Techniques for Contact Pairs
- Interference Fit Example
- Precise Specification of Clearances
- Geometric Smoothing for Curved Surfaces
- Workshop 5: Interference Fit Analysis (IA)
- Workshop 5: Interference Fit Analysis (KW)
- Workshop 6: Syringe Analysis (IA)
- Workshop 6: Syringe Analysis (KW)

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

**3 hours**

# Lesson 7: Additional Features

***Lesson content:***

- Beam Contact
- Tie Constraints
- Rigid Bodies and Contact
- Analytical Rigid Surfaces
- Pre-Tensioning of Cross-Sections
- Pressure Penetration
- Contact in Linear Perturbation Procedures
- Workshop 7: Pipe Reel Analysis (IA)
- Workshop 7: Pipe Reel Analysis (KW)

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

**2 hours**

# Lesson 8: Modeling Tips

***Lesson content:***

- Initial Rigid Body Motion
- Overconstraint
- Contact with Quadratic Elements
- Unsymmetric Matrices in Finite-Sliding Problems
- Dynamic Instabilities
- Modeling Corners and Edges
- Workshop 8: Bolted Flange Analysis: Infinitesimal Sliding (IA)
- Workshop 8: Bolted Flange Analysis: Infinitesimal Sliding (KW)
- Workshop 9: Snap Fit Analysis (IA)
- Workshop 9: Snap Fit Analysis (KW)
- Workshop 10: Analysis of a Radial Shaft Seal (IA)
- Workshop 10: Analysis of a Radial Shaft Seal (KW)

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

**2 hours**

# Appendix 1: Node-to-Surface Formulation

***Appendix content:***

- Discretization
- Finite Sliding: Surface Considerations
- Small Sliding Characteristics
- Small Sliding: Local Contact Plane
- Small Sliding: Surface Considerations



**1.5 hours**

# Appendix 2: Contact Elements

***Appendix content:***

- Surface-Based vs. Contact Element Approach
- Contact Elements
- Contact Element Output
- Contact Element Visualization

**1 hour**

# Appendix 3: Dynamic Contact using Implicit Integration

***Appendix content:***

- Time Integration Issues
- Implicit Dynamics
- Damping
- Impact Problems

**1 hour**