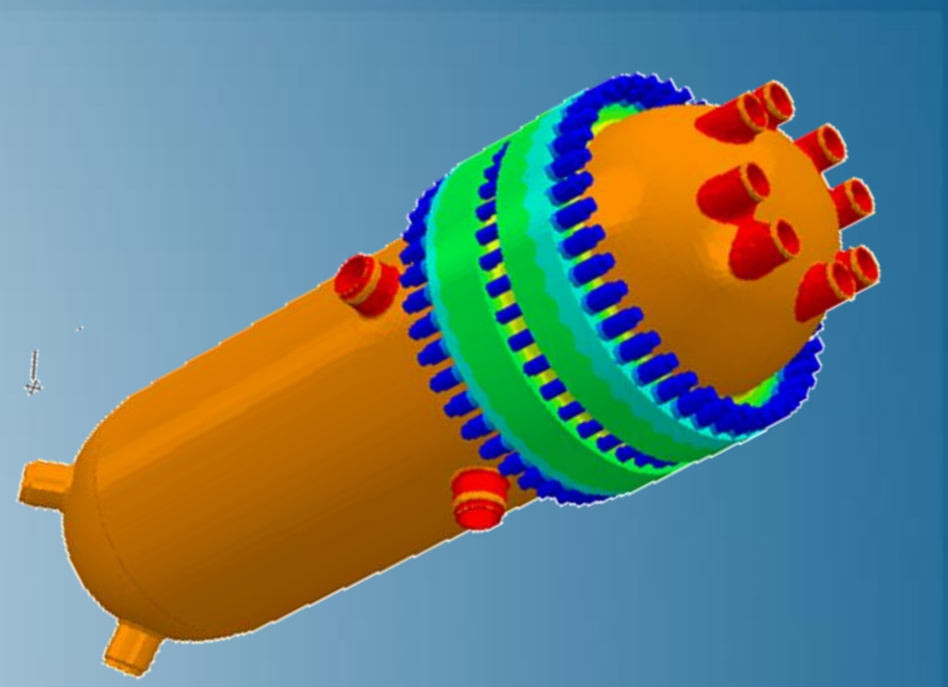
Heat Transfer and Thermal-Stress Analysis with Abaqus

Abaqus 2018



3DEXPERIENCE®

About this Course

Course objectives

Upon completion of this course you will be able to:

- Perform steady-state and transient heat transfer simulations
- Solve cavity radiation problems
- Model latent heat effects
- Perform adiabatic, sequentially-coupled, and fully-coupled thermal-stress analyses
- Model contact in heat transfer problems

Targeted audience

Simulation Analysts

Prerequisites

This course is recommended for engineers with experience using Abaqus

2 days

Day 1

- Lecture 1 — Introduction to Heat Transfer
  - Demo 1: — Heat Conduction through a Multilayered System
- Lecture 2 — Material Properties and Element Technology
  - Demo 2: — Heat Transfer Analysis using Composite Layups
  - Workshop 1 — Reactor: Properties and Elements
- Lecture 3 — Thermal Analysis Procedures
  - Workshop 2 — Reactor: Analysis Procedures
- Lecture 4 — Thermal Loads and Boundary Conditions
  - Workshop 3 — Reactor: Loads and Boundary Conditions
- Lecture 5 — Thermal Interfaces
  - Demon 3: — Thermal Radiation
  - Workshop 4 — Reactor: Thermal Contact and Analysis

Day 2

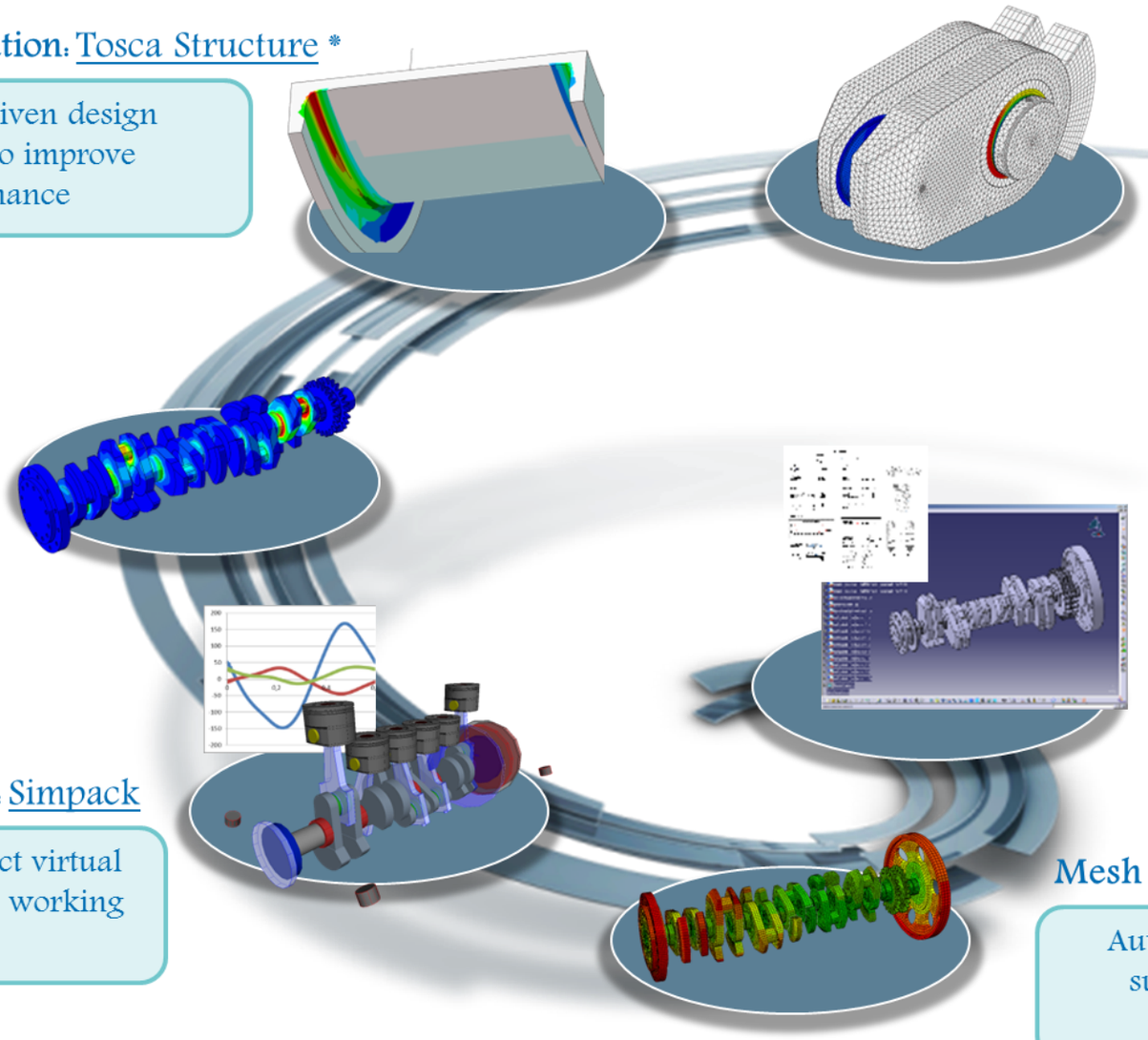
- Lecture 6 Thermal-Stress Analysis
- Lecture 7 Sequentially-Coupled Thermal-Stress Analysis
  - Demo 4: Thermally Insulated Bolted Joint
  - Workshop 5 Reactor: Stress Response
- Lecture 8 Fully-Coupled Thermal-Stress Analysis
  - Workshop 6 Disc Brake Analysis
- Lecture 9 Adiabatic Analysis

Additional Material

- Appendix 1 Heat Transfer Theory
- Appendix 2 Forced Convection
  - Workshop 7 Continuous Casting
- Appendix 3 Cavity Radiation
  - Workshop 8 Radiation in a Finned Surface
- Appendix 4 Thermal Fatigue

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 *

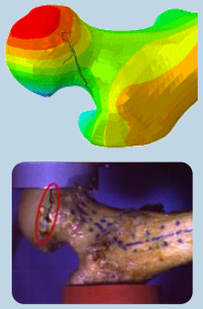
Automated mesh calibration: sufficient mesh quality for accurate results

* Included in extended licensing pool

SIMULIA's Power of the Portfolio

Abaqus

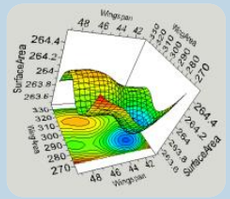
- Routine and Advanced Simulation
- Linear and Nonlinear, Static and Dynamic
- Thermal, Electrical, Acoustics
- Extended Physics through Co-simulation
- Model Preparation and Visualization



Realistic Human Simulation
High Speed Crash & Impact
Noise & Vibration

Isight

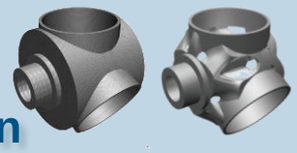
- Process Integration
- Design Optimization
- Parametric Optimization
- Six Sigma and Design of Experiments



Material Calibration
Workflow Automation
Design Exploration

Tosca

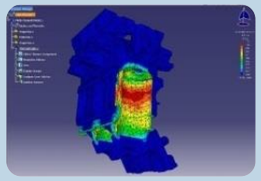
- Non-Parametric Optimization
- Structural and Fluid Flow Optimization
- Topology, Sizing, Shape, Bead Optimization



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

fe-safe

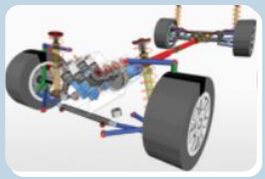
- Durability Simulation
- Low Cycle and High Cycle Fatigue
- Weld, High Temperature, Non-metallics



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 ?

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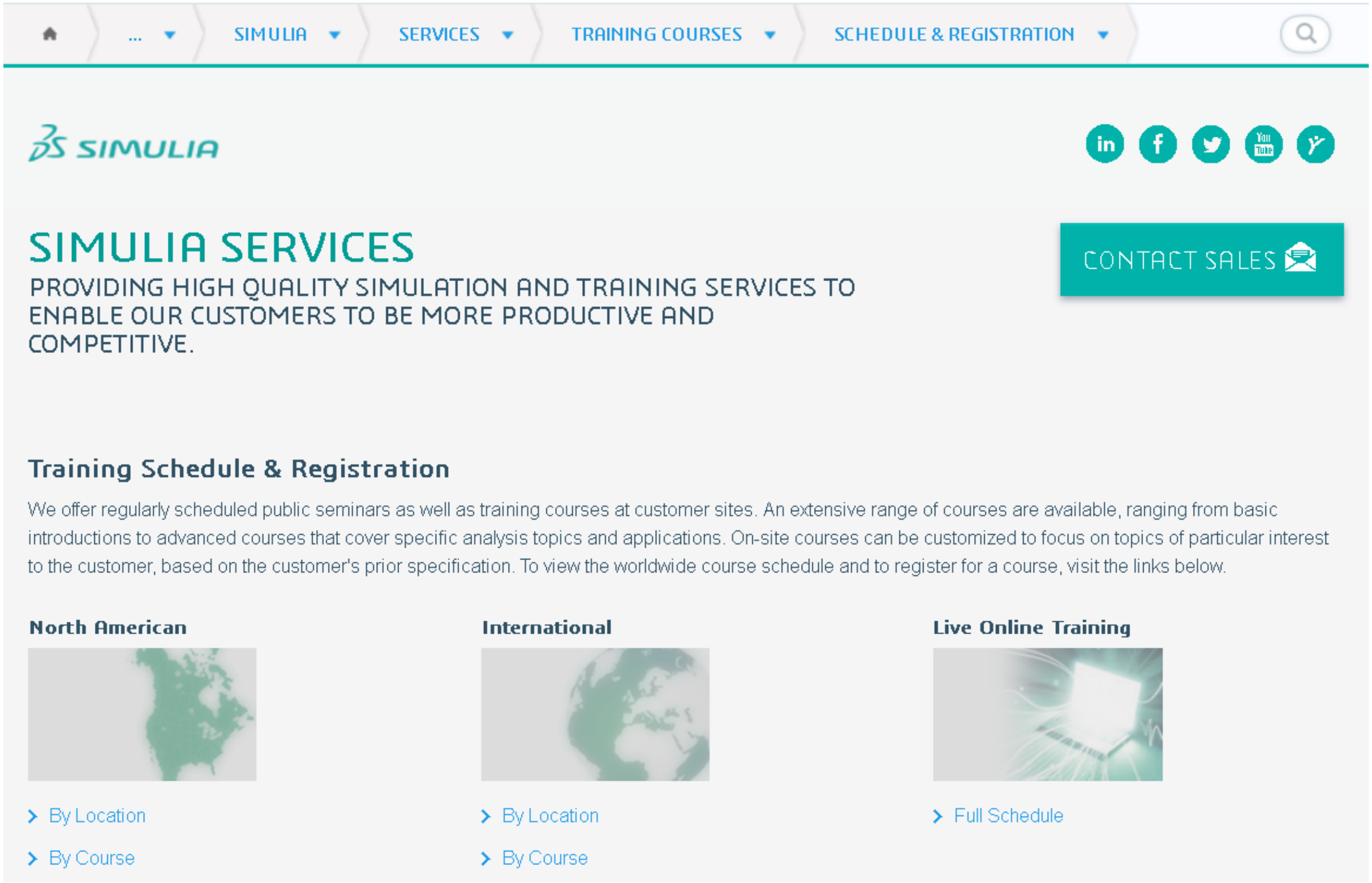

Legal Notices

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
Lecture 9	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
Appendix 4	11/17	Updated for Abaqus 2018

Demonstration 1	11/17	New for Abaqus 2018
Demonstration 2	11/17	New for Abaqus 2018
Demonstration 3	11/17	New for Abaqus 2018
Demonstration 4	11/17	New 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: Introduction to Heat Transfer

Lesson content:

- Motivation
- Multiphysics
- Heat Transfer Basics
- Conduction
- Radiation
- Convection
- Combined Modes
- Heat Transfer Abaqus Features
- Example
- Useful Conversion Factors
- Demonstration 1: Heat Conduction through a Multilayered System

45 minutes

Lesson 2: Material Properties and Element Technology

Lesson content:

- Thermal Material Properties
- Heat Transfer Element Library
- Demonstration 2: Heat Transfer Analysis using Composite Layups
- Workshop Preliminaries
- Workshop 1: Reactor: Properties and Elements (IA)
- Workshop 1: Reactor: Properties and Elements (KW)

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

1.5 hours

Lesson 3: Thermal Analysis Procedures

Lesson content:

- Steady-State Analysis
- Transient Analysis
- Nonlinear Analysis
- Output
- Workshop 2: Reactor: Analysis Procedures (IA)
- Workshop 2: Reactor: Analysis Procedures (KW)

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

1.5 hours

Lesson 4: Thermal Boundary Conditions and Loads

Lesson content:

- Overview
- Prescribed Temperatures
- Prescribed Fluxes
- Film Conditions
- Radiation to the Ambient
- Symmetry Boundary Conditions
- Initial Conditions
- Workshop 3: Reactor: Loads and Boundary Conditions (IA)
- Workshop 3: Reactor: Loads and Boundary Conditions (KW)

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

1.5 hours

Lesson 5: Thermal Interfaces

Lesson content:

- Thermal "Contact"
- Heat Transfer Across Interfaces
- Thermal Interaction Usage
- Gap Conductance
- Gap Radiation
- Demonstration 3: Thermal Radiation
- Workshop 4: Reactor: Thermal Contact and Analysis (IA)
- Workshop 4: Reactor: Thermal Contact and Analysis (KW)

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

2 hours

Lesson 6: Thermal-Stress Analysis

Lesson content:

- Analogy Between Heat Transfer and Stress Analysis
- Thermal-Stress Procedures
- Element Selection

30 minutes

Lesson 7: Sequentially-Coupled Thermal-Stress Analysis

Lesson content:

- Sequentially-Coupled Analysis
- Thermal-Stress Modeling Considerations
- Methods for Assigning Temperature Data
- Temperature Application for Solid Elements
- Temperature Application for Shell Elements
- Temperature Application for Beam Elements
- Summary
- Demonstration 4: Thermally Insulated Bolted Joint
- Workshop 5: Reactor: Stress Response (IA)
- Workshop 5: Reactor: Stress Response (KW)

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

2 hours

Lesson 8: Fully-Coupled Thermal-Stress Analysis

Lesson content:

- Full Temperature-Displacement Coupling
- Element Selection
- Contact Interaction
- Examples of Fully Coupled Analyses
- Rigid Bodies in Thermal-Stress Analysis
- Heat Transfer Analysis with Abaqus/Explicit
- Workshop 6: Disc Brake Analysis (IA)
- Workshop 6: Disc Brake Analysis (KW)

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

2 hours

Lesson 9: Adiabatic Analysis

Lesson content:

- Adiabatic Analysis
- Adiabatic Analysis Examples

30 minutes

Appendix 1: Heat Transfer Theory

Appendix content:

- Summary of Governing Equations for Conduction
- Constitutive Relation—Fourier's Law
- Thermal Energy Balance—Differential Form
- Thermal Energy Balance—Equivalent Variational Form
- Finite Element Approximation
- Transient Analysis
- Eulerian Formulation for Convection
- Thermal Radiation Formulation
- Adiabatic Thermal-Stress Analysis
- Nonlinear Solution Scheme

1 hour

Appendix 2: Forced Convection

Appendix content:

- Example: 1-D Convective Heat Transfer
- Stabilization
- Convective/Diffusive Element Library
- Abaqus Usage
- Workshop 7: Continuous Casting (IA)
- Workshop 7: Continuous Casting (KW)

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

1 hour

Appendix 3: Cavity Radiation

Appendix content:

- Thermal Radiation
- Cavity Radiation
- Fully Implicit Cavity Radiation Approach
- Open vs. Closed Cavities
- Cavity Radiation and Viewfactor Calculations
- Radiation Symmetry
- Radiation Motion
- Cavity Radiation Output
- Approximate Cavity Radiation Approach
- Workshop 8: Radiation in a Finned Surface (IA)
- Workshop 8: Radiation in a Finned Surface (KW)

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

3 hours

Appendix 4: Thermal Fatigue

Appendix content:

- Thermal Fatigue
- Example

30 minutes