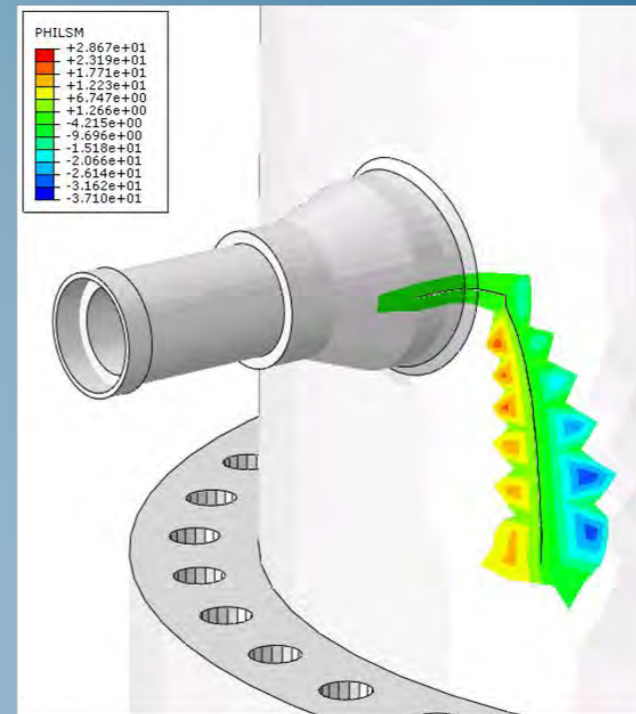


Modeling Fracture and Failure with Abaqus

R2016



3DEXPERIENCE



About this Course

Course objectives

Upon completion of this course you will be able to:

- ▶ Use proper modeling techniques for capturing crack-tip singularities in fracture mechanics problems
- ▶ Use Abaqus/CAE to create meshes appropriate for fracture studies
- ▶ Calculate stress intensity factors and contour integrals around a crack tip
- ▶ Simulate material damage and failure
- ▶ Simulate crack growth using cohesive behavior, VCCT, and XFEM
- ▶ Simulate low-cycle fatigue crack growth

Targeted audience

Simulation Analysts

Prerequisites

This course is recommended for engineers with experience using Abaqus



3 days

Day 1

- ▶ Lecture 1 Basic Concepts of Fracture Mechanics
- ▶ Lecture 2 Modeling Cracks
- ▶ Lecture 3 Fracture Analysis
 - Workshop 1 Crack in a Three-point Bend Specimen
 - Workshop 2 Crack in a Helicopter Airframe Component

Day 2

- ▶ Lecture 4 Material Failure and Wear

- ▶ Lecture 5 Element-based Cohesive Behavior
 - Workshop 3 Crack Growth in a Three-point Bend Specimen using Cohesive Connections (Part 1)

 - Workshop 4 Crack Growth in a Helicopter Airframe Component using Cohesive Elements

- ▶ Lecture 6 Surface-based Cohesive Behavior
 - Workshop 3 Crack Growth in a Three-point Bend Specimen using Cohesive Connections (Part 2)

Day 3

- ▶ Lecture 7 Virtual Crack Closure Technology (VCCT)
 - Workshop 5 Crack Growth in a Three-point Bend Specimen using VCCT

- ▶ Lecture 8 Low-cycle Fatigue

- ▶ Lecture 9 Mesh-independent Fracture Modeling (XFEM)
 - Workshop 6 Crack Growth in a Three-point Bend Specimen using XFEM

 - Workshop 7 Modeling Crack Propagation in a Pressure Vessel with Abaqus using XFEM

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Lesson 1: Basic Concepts of Fracture Mechanics

Lesson content:

- ▶ Overview
- ▶ Introduction
- ▶ Fracture Mechanisms
- ▶ Linear Elastic Fracture Mechanics
- ▶ Small Scale Yielding
- ▶ Energy Considerations
- ▶ The J-integral
- ▶ Nonlinear Fracture Mechanics
- ▶ Mixed-Mode Fracture
- ▶ Interfacial Fracture
- ▶ Creep Fracture
- ▶ Fatigue



1.5 hours

Lesson 2: Modeling Cracks

Lesson content:

- ▶ Crack Modeling Overview
- ▶ Modeling Sharp Cracks in Two Dimensions
- ▶ Modeling Sharp Cracks in Three Dimensions
- ▶ Finite-Strain Analysis of Crack Tips
- ▶ Limitations Of 3D Swept Meshing For Fracture
- ▶ Modeling Cracks with Keyword Options



1.5 hours

Lesson 3: Fracture Analysis

Lesson content:

- ▶ Calculation of Contour Integrals
- ▶ Examples
 - Penny-shaped crack in an infinite space
 - Conical crack in a half-space
 - Compact Tension Specimen
- ▶ Nodal Normals in Contour Integral Calculations
- ▶ J-Integrals at Multiple Crack Tips
- ▶ Through Cracks in Shells
- ▶ Mixed-Mode Fracture
- ▶ Material Discontinuities
- ▶ Numerical Calculations with Elastic-Plastic Materials
- ▶ Residual Stresses
- ▶ Workshop Preliminaries
- ▶ Workshop 1: Crack in a Three-point Bend Specimen
- ▶ Workshop 2: Crack in a Helicopter Airframe Component



3 hours

Lesson 4: Material Failure and Wear

Lesson content:

- ▶ Progressive Damage and Failure
- ▶ Damage Initiation Criteria for Ductile Metals
- ▶ Damage Evolution
- ▶ Element Removal
- ▶ Damage in Fiber-Reinforced Composite Materials
- ▶ Damage in Fasteners
- ▶ Material Wear and Ablation



2 hours

Lesson 5: Element-based Cohesive Behavior

Lesson content:

- ▶ Overview
- ▶ Introduction
- ▶ Element Technology
- ▶ Constitutive Response
- ▶ Viscous Regularization
- ▶ Modeling Techniques
- ▶ Examples
- ▶ Workshop 3: Crack Growth in a Three-point Bend Specimen using Cohesive Connections (Part 1)
- ▶ Workshop 4: Crack Growth in a Helicopter Airframe Component using Cohesive Elements



3 hours

Lesson 6: Surface-based Cohesive Behavior

Lesson content:

- ▶ Surface-based Cohesive Behavior
- ▶ Element- vs. Surface-based Cohesive Behavior
- ▶ Workshop 3: Crack Growth in a Three-point Bend Specimen using Cohesive Connections (Part 2)



1.5 hours

Lesson 7: Virtual Crack Closure Technique (VCCT)

Lesson content:

- ▶ Introduction
- ▶ VCCT Criterion
- ▶ LEFM Example using Abaqus/Standard
- ▶ LEFM Example using Abaqus/Explicit
- ▶ Output
- ▶ Ductile Fracture with VCCT
- ▶ VCCT Plug-in
- ▶ Comparison with Cohesive Behavior
- ▶ Examples
- ▶ Workshop 5: Crack Growth in a Three-point Bend Specimen using VCCT



2 hours

Lesson 8: Low-cycle Fatigue

Lesson content:

- ▶ Introduction
- ▶ Low-cycle Fatigue in Bulk Materials
- ▶ Low-cycle Fatigue at Material Interfaces



1 hour

Lesson 9: Mesh-independent Fracture Modeling (XFEM)

Lesson content:

- ▶ Introduction
- ▶ Basic XFEM Concepts
- ▶ Damage Modeling
- ▶ Cohesive Damage Modeling
- ▶ LEFM-based Damage Modeling
- ▶ Creating an XFEM Fracture Model
- ▶ Example 1 – Crack Initiation and Propagation using Cohesive Damage
- ▶ Example 2 – Crack Initiation and Propagation using LEFM
- ▶ Example 3 – Low Cycle Fatigue
- ▶ Example 4 – Propagation of an Existing Crack
- ▶ Example 5 – Delamination and Through-thickness Crack Propagation
- ▶ Example 6 – Contour Integrals
- ▶ Example 7 – Pressure Penetration
- ▶ Modeling Tips
- ▶ Limitations
- ▶ Workshop 6: Crack Growth in a Three-point Bend Specimen using XFEM
- ▶ Workshop 7: Modeling Crack Propagation in a Pressure Vessel with Abaqus using XFEM



3 hours