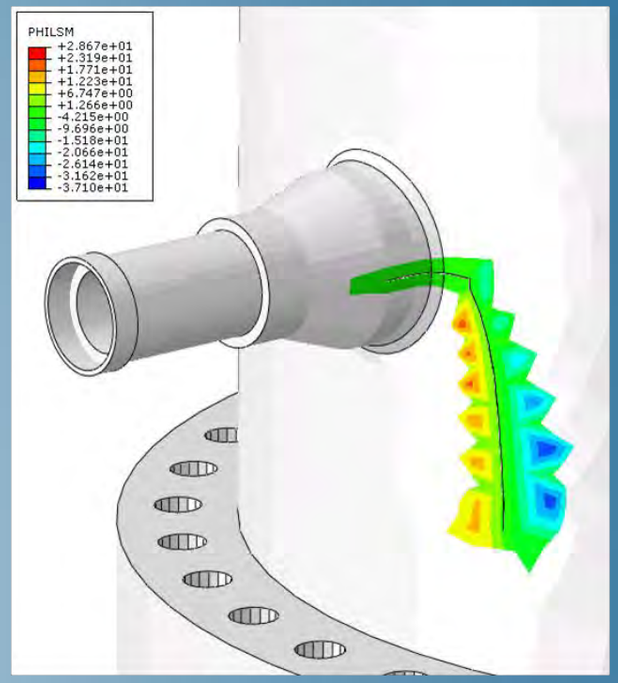
Modeling Fracture and Failure with Abaqus

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

Legal Notices

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