Tire Analysis with Abaqus: Fundamentals
Abaqus 2019
Course objectives
In this course you will learn about:

- Choosing appropriate elements
- Methods of modeling reinforcement
- Contact modeling details pertinent to tire modeling
- Fundamentals of material modeling-stress and strain measures, material directions
- Linear elasticity, hyperelasticity and viscoelasticity
- Efficient axisymmetric to three-dimensional model generation and results transfer

Targeted audience
This course is recommended for tire analysts with experience using Abaqus

Prerequisites
None
Day 1

- Lecture 1  Tire Modeling Tools in Abaqus
- Lecture 2  Axisymmetric Model Building
- Workshop 1 Modeling a Tire Cross-section
- Lecture 3  Symmetric Model Generation and Results Transfer
Day 2

- Lecture 4  Three-dimensional Model Building
  - Workshop 2  Three-dimensional Tire Models
  - Workshop 3  Visualization of Three-dimensional Tire Models
- Lecture 5  Elements and Reinforcement
- Lecture 6  Modeling Contact
- Lecture 7  Rubber Models for Tire Analysis
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- Extended Physics through Co-simulation
- Model Preparation andVisualization

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

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

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

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

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

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

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

**Safety Factors**
- Creep-Fatigue Interaction
- Weld Fatigue

**Complete System Analyses**
- (Quasi-)Static, Dynamics, NVH
- Flex Bodies, Advanced Contact
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Lesson 1: Tire Modeling Tools in Abaqus

Lesson content:

- Introduction
  - Prerequisites for the course (basic Abaqus/CAE and analysis knowledge)
- Tire Analysis Capabilities
- How Tires are Made
  - Green tire vs. cured tire
  - Effect on rebar specification in analysis models

30 minutes
Lesson content:

- Why Start with Axisymmetry?
- Creation of Rim, Carcass, Ply and Belt Geometries
- Workshop Preliminaries
- Workshop 1a: Modeling a tire cross-section – Modeling the tire cross-section
- Reinforcement Modeling
- Material Properties and Assignment
- Workshop 1b: Modeling a tire cross-section – Tire properties and rebar definitions
- Contact and Constraints
- Boundary Conditions and Loads
- Steps and Output Requests
- Workshop 1c: Modeling a tire cross-section – Contact, loads, and boundary conditions
- Meshing
- Workshop 1d: Modeling a tire cross-section – Axisymmetric mesh
- Job Submission
- Results Visualization
- Workshop 1e: Modeling a tire cross-section – Axisymmetric tire analysis

4.5 hours
Lesson content:

- Introduction
- Smooth/Ribbed Tires: Symmetric Model Generation
- Smooth/Ribbed Tires: Symmetric Results Transfer
- Treaded Tires

1 hour
Lesson content:

- **Introduction**
  - What is SMG/SRT? (flattened model requirement, etc.)
- **3D Model Definition**
  - Element types (general vs. cylindrical)
  - Circumferential discretization
  - Model generation (road, tread surface)
- **Step and Output Requests**
  - Equilibrating step
  - 2-step approach to footprint analysis (displacement control followed by load control)
- **Contact, Boundary Conditions, and Loads**
- **Job Submission and Results Visualization**
- **Tire Wizard Plug-In**
- **Workshop 2: Three-dimensional Tire Models**
- **Workshop 3: Visualization of Three-dimensional Tire Models**
Lesson content:

- Introduction
- Element Selection
- Modeling Reinforcement
- Rebar Layers
- Embedded Elements

Lesson 5: Elements and Reinforcement

2 hours
Lesson 6: Modeling Contact

Lesson content:

- Overview of Contact
- Contact Discretization
- Contact Enforcement
- Finite Sliding of Deformable Bodies against Each Other
- Finite Sliding of Deformable Bodies against Rigid Bodies
- Additional Features
- Friction Basics

1 hour
Lesson 7: Rubber Models for Tire Analysis

Lesson content:

- Introduction
- Stress and Strain Measures
- Material Directions
- Temperature and Field Variable Dependence
- Hyperelasticity

1 hour