

Writing User Subroutines with Abaqus

Abaqus 2018





3DEXPERIENCE[®]

About this Course

Course objectives

In this course you will learn about:

- When and how to use subroutines
- DLOAD, VDLOAD, and UTRACLOAD for specifying user-defined loading
- FILM for specifying user-defined film conditions
- USDFLD and VUSDFLD for defining field variable dependence
- UVARM for defining a user output variable
- UHYPER for modeling hyperelastic materials
- UMAT and VUMAT for allowing constitutive models to be added to the program
- UEL and VUEL for allowing the creation of user-defined elements

Targeted audience

This course is recommended for engineers with experience using Abaqus.

Prerequisites

A working knowledge of the finite element method and programming in either Fortran or C



Day 1

- Lecture 1 Introduction
- Lecture 2 User Subroutines (V)DLOAD and UTRACLOAD
- Lecture 3 User Subroutine FILM
 - Workshop 1 User Subroutine FILM
- Lecture 4 User Subroutine (V)USDFLD
- Lecture 5 User Subroutine UVARM

- Lecture 6 User Subroutine UHYPER
- Lecture 7 Writing a UMAT or VUMAT
 - Workshop 2 User Subroutine UMAT: Tangent Stiffness
- Lecture 8 Creating a Nonlinear User Element (UEL and VUEL)

Additional Material

- Appendix 1 Logical Modeling in Abaqus
 - Workshop 3 Controlling an Inverted Pendulum with VUAMP
- Appendix 2 User Subroutine URDFIL
- Appendix 3 User Subroutine (V)UANISOHYPER
 - Workshop 4 User Subroutine UANISOHYPER_INV: anisotropic hyperelastic material behavior
- Appendix 4 Introduction to Parallel Computing
- Appendix 5 Getting Started with Abaqus Parallel Execution
 - Workshop 5 User Subroutines with Threads
 - Workshop 6 User Subroutines with MPI
- Appendix 6 Accessing Table Collections in User Subroutines
 - Workshop 7 User Table: Implementation with User Subroutine Film
 - Workshop 8 User Table: Implementation with User Subroutine Creep

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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
Appendix 4	11/17	Updated for Abaqus 2018
Appendix 5	11/17	Updated for Abaqus 2018
Appendix 6	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	New for Abaqus 2018
Workshop 8	11/17	New for Abaqus 2018

Lesson 1: Introduction

- Overview of Some User Subroutines
- Where User Subroutines Fit into Abaqus/Standard
- Including User Subroutines in a Model
- Writing Output from User Subroutines
- Compiling and Linking User Subroutines
- Debugging Techniques and Proper Programming Habits
- C/C++ interface
- Property and Parameter Tables
- Support for User Subroutines



Lesson 2: User Subroutines (V)DLOAD and UTRACLOAD

- Introduction
- Abaqus Usage
- DLOAD Subroutine Interface
- Example: Viscoelastic Cylinder
- Example: Asymmetric Pressure Loads
- VDLOAD Subroutine Interface
- Example: Viscoelastic Cylinder Revisited
- UTRACLOAD Subroutine Interface
- Example: Flexure of a Cantilever Beam



Lesson 3: User Subroutine FILM

Lesson content:

- Introduction
- Abaqus Usage
- FILM Subroutine Interface
- Example: Radiation in Finned Surface
- Workshop Preliminaries
- Workshop 1: User Subroutine FILM (IA)
- Workshop 1: User Subroutine FILM (KW)



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



Lesson 4: User Subroutine (V)USDFLD

- Introduction
- Abaqus Usage
- Utility Routine GETVRM
- USDFLD Subroutine Interface
- Example: Laminated Composite Plate Failure
- Utility Routine VGETVRM
- VUSDFLD Subroutine Interface
- Example: Laminated Composite Plate Failure Revisited



Lesson 5: User Subroutine UVARM

- Introduction
- Abaqus Usage
- UVARM Subroutine Interface
- Example 1: Calculation of Stress Relative to Shift Tensor
- Example 2: Creating Contour Plots for UELs



Lesson 6: User Subroutine UHYPER

- Overview
- Motivation
- Steps Required in Writing a UHYPER
- ▶ UHYPER Interface
- Example 1: UHYPER for Neo-Hookean Hyperelasticity



Lesson 7: Writing a UMAT or VUMAT

- Overview
- Motivation
- Steps Required in Writing a UMAT or VUMAT
- UMAT Interface
- Example 1: UMAT for Isotropic Isothermal Elasticity
- Example 2: UMAT for Non-Isothermal Elasticity
- Example 3: UMAT for Neo-Hookean Hyperelasticity
- Example 4: UMAT for Kinematic Hardening Plasticity
- Example 5: UMAT for Isotropic Hardening Plasticity
- VUMAT Interface
- Example 6: VUMAT for Isotropic Isothermal Elasticity
- Example 7: VUMAT for Neo-Hookean Hyperelasticity
- Example 8: VUMAT for Kinematic Hardening Plasticity
- Example 9: VUMAT for Isotropic Hardening Plasticity
- Workshop 2: User Subroutine UMAT: Tangent Stiffness (IA)
- Workshop 2: User Subroutine UMAT: Tangent Stiffness (KW)





Lesson 8: Creating a Nonlinear User Element

- Overview
- Motivation
- Defining a User Element in Abaqus/Standard
- UEL Interface
- Example 1: Planar Beam Element with Nonlinear Section Behavior
- Example 2: Force Control Element
- Example 3: Plane Strain Element
- UELMAT Interface
- Using Nonlinear User Elements in Various Analysis Procedures
- Defining a User Element in Abaqus/Explicit
- VUEL Interface
- Example 4: Three-Dimensional Truss Element



Appendix 1: Logical Modeling in Abaqus

Appendix content:

- Introduction
- Defining Logical Modeling
- Example: Force Control
- Workshop 3: Controlling an Inverted Pendulum with VUAMP (IA)
- Workshop 3: Controlling an Inverted Pendulum with VUAMP (KW)



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



Appendix 2: User Subroutine URDFIL

- Introduction
- Abaqus Usage
- URDFIL Subroutine Interface
- Example: Using URDFIL to Terminate an Analysis



Appendix 3: User Subroutine (V)UANISOHYPER

- Overview
- Motivation
- Steps Required in Writing a UANISIOHYPER or VUANISOHYPER
- UANISOHYPER_INV interface
- Example 1: UANISOHYPER_INV for Kaliske and Schmidt
- UANISOHYPER_STRAIN Interface
- Example 2: UANISOHYPER_STRAIN for Saint-Venant Kirchhoff
- VUANISOHYPER_INV interface
- Example 3: VUANISOHYPER_INV for Kaliske and Schmidt
- VUANISOHYPER_STRAIN Interface
- Example 4: VUANISOHYPER_STRAIN for Saint-Venant Kirchhoff
- Workshop 4: User Subroutine UANISOHYPER_INV: Anisotropic hyperelastic material behavior



Appendix 4: Introduction to Parallel Computing

- Overview
- What is Parallel Computing?
- Why do we use Parallel Computing?
- Computer Memory Architecture Basics
- Different Models of Parallel Computing
- Limits of Parallel Computing
- Challenges of Parallel Computing
- Abaqus Performance Benchmark



Appendix 5: Getting Started with Abaqus Parallel Execution

- Overview
- Parallel Execution in User Subroutines
- User Subroutines with Threads
- User Subroutines with MPI
- User Subroutines with hybrid MPI and Threads
- Workshop 5: User Subroutines with Threads
- Workshop 6: User Subroutines with MPI



Appendix 6: Accessing Table Collections in User Subroutines

Appendix content:

- Overview
- Property Tables, Parameter Tables and Table Collections
- Property Tables
- Parameter Tables
- Table Collections
- Utility Routines: Accessing User Data in User Subroutines
- Example of Keyword Interface and Subroutine Usage
- Workshop 7: Implementation with User Subroutine FILM (IA)
- Workshop 7: Implementation with User Subroutine FILM (KW)
- Workshop 8: Implementation with User Subroutine CREEP (IA)
- Workshop 8: Implementation with User Subroutine CREEP (KW)



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

