DYMOLA AND MODELICA
Course overview
DAY 1

Dymola and Modelica I

• Introduction Dymola, Modelica, Modelon
• Lecture 1 Overview of Dymola and Physical modeling
  ▪ Workshop 1 Workflow of modeling physical systems in Dymola
• Lecture 2 Simulation and post-processing with Dymola
  ▪ Workshop 2 Simulating and analyzing a physical system
• Lecture 3 Configure system models
  ▪ Workshop 3 Creating a reconfigurable system
DYMOLA AND MODELICA I

- Lecture 4
  - Workshop 4a: Cauer low pass filter using Electric Library
  - Workshop 4b: A moving coil using Magnetic, Electric and Translational mechanics libraries
  - Workshop 4c: Temperature control using Heat transfer Library

- Lecture 5: Understanding equation-based modeling
  - Workshop 5: Defining boundary conditions

- Lecture 6: Trouble shooting and common pitfalls
  - Workshop 6: Common pitfalls
DAY 3

Dymola and Modelica II

- Lecture 7  
  - Workshop 7  Implementing a solar collector
- Lecture 8  
  - Workshop 8a  Lamp logic using StateGraph II
  - Workshop 8b  Suspension linkage using MultiBody mechanics
- Lecture 9  
  - Workshop 9a  Hybrid examples
  - Workshop 9b  Hammer impact model
  - Workshop 9c  Designing a thermostat valve

Modelica II – Advanced features
Working with the Modelica Standard Library

DAY 3
DAY 4

Dymola and Modelica II

- Lecture 10  
  - Workshop 10  
    Efficient and reconfigurable modeling
    Creating a system architecture based on templates and interfaces

- Lecture 11  
  - Workshop 11  
    Model variants and data management
    Creating a data architecture and adaptive parameter interfaces

- Lecture 12  
  - Workshop 12a  
    Import and Export FMUs in Dymola
  - Workshop 12b  
    FMI with Excel
  - Workshop 12c  
    FMI with Simulink
DAY 5

Dymola and Modelica II

- Lecture 13  Workflow automation and scripting
  - Workshop 13  Automated sensitivity analysis

- Lecture 14  Dymola code with other tools
  - Workshop 14a  Source code and binary export
  - Workshop 14b  External functions and external objects
  - Workshop 14c  Simulink export

- Lecture 15  Introduction to real-time
  - Workshop 15  Configuring a model for real-time simulation
LECTURE 1
Overview of Dymola and physical modeling
OVERVIEW

• Overview of Dymola
• Documentation
• Creating a new model
• Defining a model with several components
  ▪ Connecting components, connectors
• Setting parameters, dialog boxes
• Interfacing:
  ▪ Connector interface
  ▪ Parameter interface
• Propagating parameters
• Organizing models in packages
• Using check in Dymola
LECTURE 2
Simulation and post-processing
OVERVIEW

• What is an experiment?
• Setting up an experiment
• Working with results
• Analysis of results
• Exporting results
• Selecting solvers
• Initial conditions
• Understanding check, translate, simulate
• Understanding the translation and simulation logs
LECTURE 3

Configure system models
OVERVIEW

• Benefits with hierarchical models
• Structuring
• Configuring hierarchical models
  ▪ Class vs component
  ▪ Navigating
  ▪ Setting and protecting parameters (encapsulation)
  ▪ Changing components
LECTURE 4

Modelica I - Writing Modelica models
OVERVIEW

• Dymola text editor
• Variables
  ▪ Modifying attributes of variables
  ▪ Units and physical quantities, unit checking
• Equations and Algorithms
  ▪ Equations
  ▪ Initial equations
  ▪ Accessing information in connectors
  ▪ Algorithms
• Arrays and matrices
• Inheritance
• Modelica Standard Library
• Multidomain modeling
LECTURE 5

Understanding equation-based modelling
OVERVIEW

• Equation-based components
  ▪ Boundary conditions
  ▪ Initialization
• Defining component boundaries
  ▪ Potential and flow variables
  ▪ Balanced models
  ▪ Over-determined connectors
  ▪ Input/output
  ▪ Stream connectors
• Degrees of freedom in a system
  ▪ State selection and index reduction
  ▪ Identifying degrees of freedom in a system
• Other Modelica classes
LECTURE 6
Troubleshooting and common pitfalls
OVERVIEW

• Development - Best practice
  ▪ Specification
  ▪ Implementation
  ▪ Maintenance
• Troubleshooting
  ▪ Translation problems
  ▪ Simulation problems
• Debugging
  ▪ Nonlinear solver diagnostics
  ▪ Min/Max assertion
  ▪ Logging options (Events, State variables)
  ▪ Online debugging
  ▪ Translation and Advanced Dymola flags
• Common problems
LECTURE 7
Modelica II – Advanced Features
OVERVIEW

• Functions
  ▪ Derivative, advanced derivative definitions
  ▪ Inverse
  ▪ Code generation annotations

• Enumerations

• Data records

• Component arrays

• Expandable connectors
  ▪ Signal bus

• Synchronous Language elements
LECTURE 8

Working with Modelica Standard Library
OVERVIEW

• StateGraph
  ▪ Fundamentals and Usage
  ▪ Modelica.StateGraph vs. Modelica_StateGraph2

• Multibody Mechanics
  ▪ Domain description and basic assumptions
  ▪ Multi-body simulation in Dymola

• Fluid
  ▪ Physical principles
  ▪ Fundamentals and usage

• Media
  ▪ Why and how is Media used?
  ▪ Fundamentals
LECTURE 9

Hybrid modeling
OVERVIEW

• What is a hybrid system?
• What is an event?
• Chattering
• Avoiding events
• Variable structures
  ▪ Parameterized curves
  ▪ State machines
LECTURE 10

Efficient and reconfigurable modeling
OVERVIEW

• Creating reconfigurable models
  ▪ Templates and interfaces
  ▪ Conditional components
  ▪ Arrays of components
• Organizing models and data
  ▪ Libraries
  ▪ Data records
LECTURE 11

Model variants and data management
OVERVIEW

- Modifiers in specific models
- Data records
- Data input blocks
- Replaceable functions
- Reading data from files
- Package constants
- Working with deeper hierarchies
LECTURE 12
FMI Technology
OVERVIEW

• Introduction and background
  ▪ Why FMI?

• What is FMI?
  ▪ The FMI standard
  ▪ What is an FMU?
  ▪ FMI Flavors

• Supported tools and testing

• FMI support in Dymola
  ▪ Options
  ▪ FMU import
  ▪ FMU export
  ▪ FMI workflow

• Using Dymola FMUs with other tools
  ▪ Supported tools
  ▪ Matlab/Simulink
  ▪ Excel
  ▪ Python
LECTURE 13
Workflow automation and scripting
OVERVIEW

• Automated analysis
• Automatic script generation
• Scripts
• Scripting using functions
• Coupling commands to a model
• Example: Generating report data
LECTURE 14

Using the Dymola code in other tools and environments
OVERVIEW

• Binary export
  ▪ Running dymosim.exe
    • Stand alone
    • Compiled with the DDE or OPC options
    • Compiled as DLL with API to C
  ▪ Source code export
• Interface for Java and Python
• External functions in Dymola
• External objects in Dymola
• Dymola-Simulink Interface
LECTURE 15
Introduction to Real-time
OVERVIEW

• Introduction
  ▪ What is real-time simulation?
  ▪ Why real-time?
  ▪ Harder requirements
  • Choosing solver
  • Fast dynamics and instability
  • Non-linear equation systems
    ▪ Analytical Jacobians

• Profiling
  ▪ Execution time analysis
  ▪ Code profiling
  ▪ Overruns
  ▪ Translation log
  • Inline integration
  • Mixed mode integration
  • Achieving real-time simulation