COMSOL

NEW FEATURE HIGHLIGHTS

VERSION 3.5a

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COMSOL New Feature Highlights

Version: November 2008 COMSOL 3.5a Part number: CM010004

New Feature Highlights

From the generation of model geometries to postprocessing simulation results, version 3.5a of COMSOL Multiphysics® and its discipline-specific add-on modules offer significant efficiency and productivity enhancements. This guide provides a brief overview of the v3.5a's new features that improve the user experience as well as enhancements that provide greater efficiency through improved use of CPU time and memory space.

We know that you find COMSOL Multiphysics an invaluable tool in your work and research. We believe that version 3.5a will prove even more valuable as you investigate ideas that spark innovation.

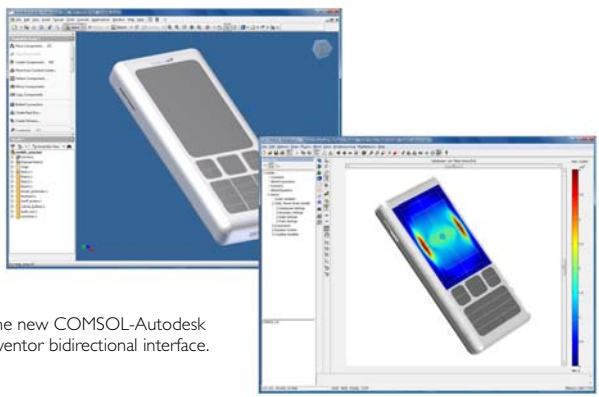
CAD Import Module and Draw Mode

The CAD Import Module now supports the Parasolid® file format from Siemens PLM Software throughout the CAD import process, making v3.5a more robust and efficient than in previous versions as well as more interoperable with third-party engineering and scientific applications. CAD parts are no longer converted to COMSOL geometry objects as part of the import process. The CAD Import Module also now runs on the Macintosh.

You can individually repair and defeature parts in an assembly, which gives additional flexibility when parts require different repair and defeaturing tolerances.

A new bidirectional interface to Autodesk® Inventor® that supports geometric parametric sweeps has been introduced in v3.5a.

The bidirectional interface to SolidWorks® has been updated and now also supports geometric parametric sweeps.



The new COMSOL-Autodesk Inventor bidirectional interface.

Application Modes, Physics Settings, and Modeling Features

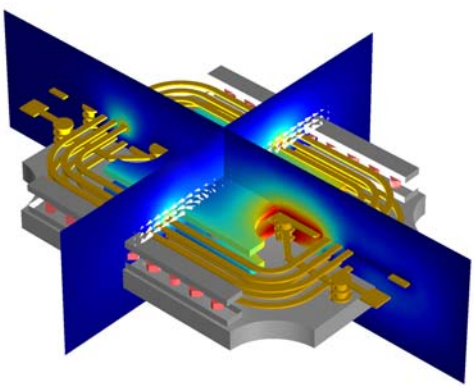
The new version of COMSOL Multiphysics features new application modes for optimization (requires Optimization Lab) and sensitivity analysis.

Version 3.5a now also runs on the 64-bit Mac OS X platform.

Saving time and effort, v3.5a lets you import external data from unstructured grids.

The *AC/DC Module* includes a new ECAD interface where you can create geometries of PCB designs imported from ODB++ files and GDS files. Using the software NETEX-G® by Artwork Conversion Software, you can also create geometries in COMSOL from Gerber/drill files.

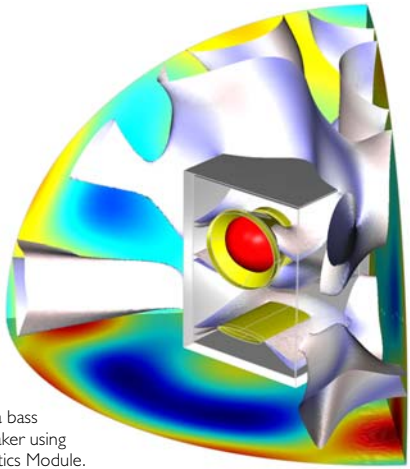
In a new interface, you can run induced-field analysis for magnetic fields by eliminating a known background field using a reduced-potential method (for example, for nondestructive testing).



Simulation of the electromagnetic field in a planar transformer using ECAD import.

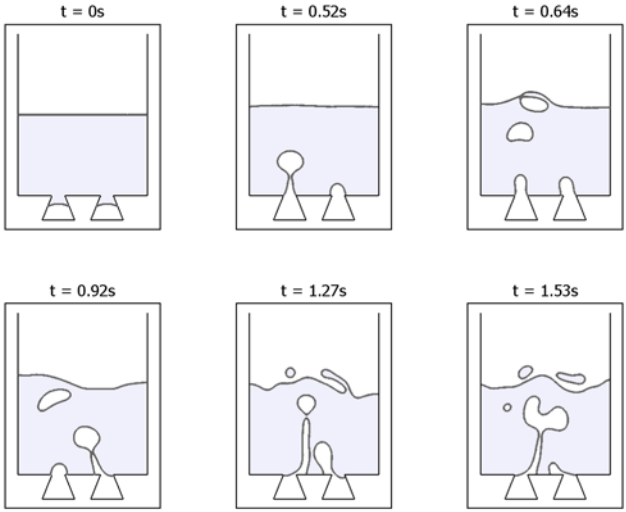
The *Acoustics Module* offers an easy-to-use interface for simulations of acoustic-structure interactions through a predefined multiphysics coupling.

Structural dampings and losses are also easy to define in a new interface in the piezoelectrical application modes.



Model of a bass reflex speaker using the Acoustics Module.

Chemical Engineering Module v3.5a features a new Two-Phase Flow, Phase Field application mode that lets you model interfaces between immiscible fluids.



Two-phase flow simulation of boiling water using the Two-Phase Flow, Phase Field application mode.

New surface tension data in the Liquids and Gases material library enhances the level set-based and phase field-based application modes.

New stabilization techniques, new solvers, and default setting refinements enhance the efficiency of all solvers for fluid flow applications substantially.

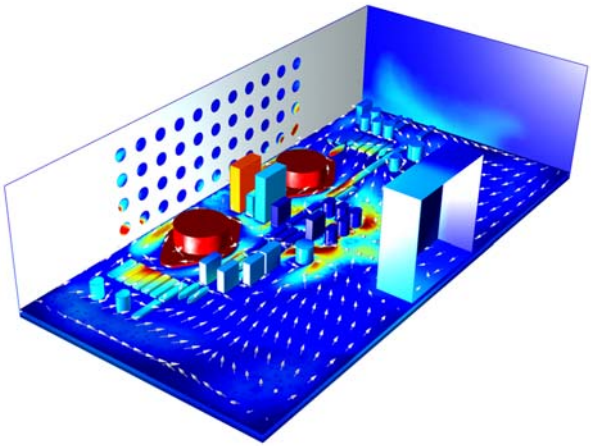
The *Earth Science Module* v3.5a, when coupled with the Structural Mechanics or MEMS Modules, now features a predefined multiphysics coupling for poroelasticity, enabling you to simulate the effects of porous media flow on stresses and strains.

The module also comes with a new material library for properties of liquids and gases.

Efficiency enhancements in the *Heat Transfer Module* v3.5a greatly improve nonisothermal flow and convective heat transfer simulations as well as provide better stabilization for modeling free convection and heat transfer in turbulent flows. Simulations of heat and flow in electronic cooling, free convection, and

general thermal management applications are now up to 8 times faster, while memory requirements for thermal stresses are down 25 percent.

In heat conduction applications, you can now run simulations of unbounded domains through the infinite elements technique.

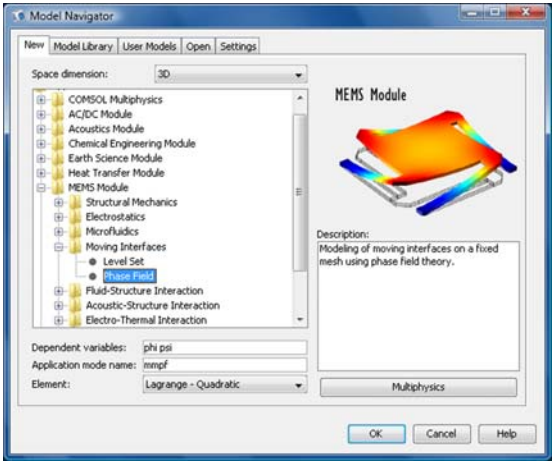


Air flow field and temperature inside an amplifier equipped with a fan on one of the vertical walls and ventilation orifices on the opposite vertical wall.

The *MEMS Module* v3.5a features application modes for multiphase flow that include data for surface tensions.

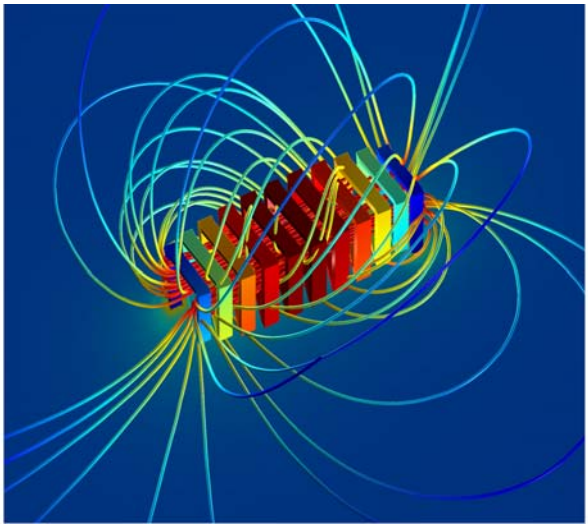
A new predefined multiphysics coupling enables you to simulate the effects of thermal-electric-structural interaction, and a new interface lets you introduce structural damping, dielectric, and coupling losses in the piezoelectrical application modes.

A new interface for viscoelastic material models, SPICE circuit integration, and the ECAD interface described above are incorporated into v3.5a.



Moving Interfaces using the phase field method is one of the new features in the MEMS Module.

The *RF Module* v3.5a introduces new circuit ports for simulating the connection of a transmission line or an antenna and an external circuit. Adaptive meshing for S-parameter analysis has been added as has the ECAD interface described above.



Electromagnetic fields and flux lines combined with thermal expansion in an RF solenoid simulated using the RF Module.

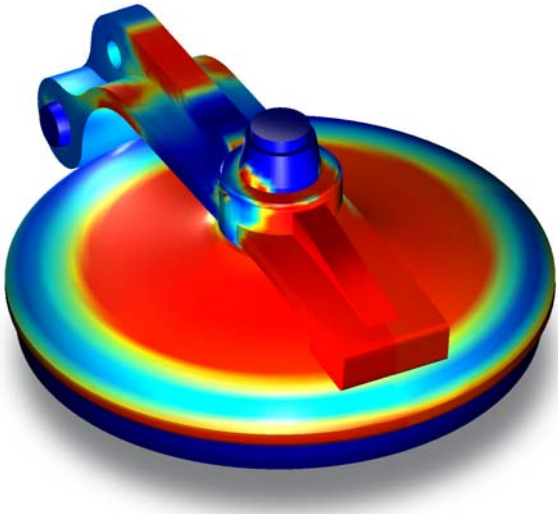
This new release extends the capabilities of the *Structural Mechanics Module* with new interfaces for viscoelastic material models and for nonlinear acoustoelasticity using the hyperelastic Murnaghan material model.

The Module also features a predefined multiphysics coupling for thermal-electric-structural simulations.

A new dialog box allows you to introduce structural damping, dielectric, and coupling losses in the piezoelectrical application modes.

Reaction forces calculated with high accuracy are now available in the postprocessing menu.

The efficiency of the solvers for structural mechanics has been substantially enhanced in this version compared to previous versions, especially for transient simulations. This is achieved through new solvers and better-tuned default settings.



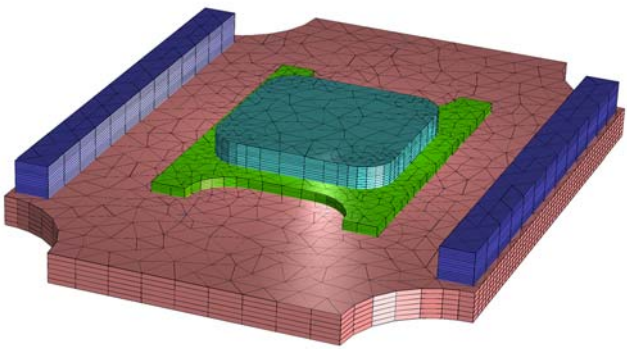
Stresses in a valve cap simulated using the Structural Mechanics Module.

Meshing

For users of the CAD Import Module, the robustness of the meshing process is substantially enhanced by meshing directly on the Parasolid geometry representation.

An advancing-front mesher, the new default mesher for 2D geometries, creates higher-quality meshes for 2D and 3D surfaces than previous versions. One-click hex-to-tet meshing and prism-to-tet meshing capabilities are new meshing options.

Version 3.5a introduces a swept meshing functionality using an *N*-to-1 surface method. This makes meshing layered structures simpler, faster, and easier.

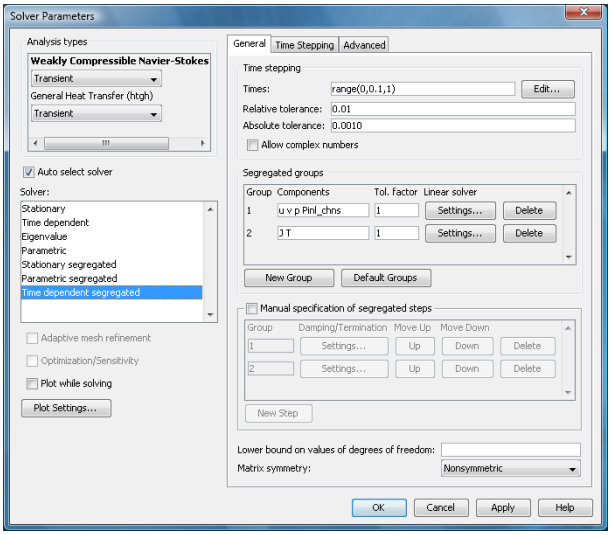


The new N-to-1 swept meshing ability in use on the meshing of a planar transformer.

Solving the Model

A new Generalized-α solver makes time-dependent structural mechanics, electromagnetic, acoustics, and fluid-flow simulations more efficient.

The segregated solver, now available for time-dependent simulations, cuts memory usage for solving weakly coupled multiphysics problems, such as thermal stresses, by as much as 50 percent. The segregated solver also offers new flexible settings that make setting up problems with various multiphysics couplings easier and faster.



COMSOL 3.5a includes a number of new features for the solution process, including a new time-dependent segregated solver.

Enhancements in v3.5a have increased execution speeds for time-domain wave simulations as well as fluid flow simulations from 2 to 8 times. A new out-of-core PARDISO linear solver reduces memory requirements when running simulations, and you can now trim solution times for highly nonlinear time-dependent simulations by tuning the tolerance of the nonlinear solver. Tighter code has boosted shared-memory parallelism speedup by 20 percent.

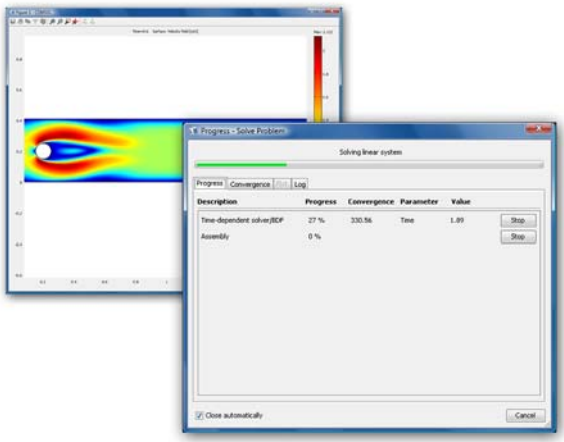
Multiple parameter sweeping is introduced using the parametric solver. In addition, you can run highly efficient parameter sweeps using the parametric solver on distributed memory systems, such as Linux and Windows clusters. Parametric sweeps can be run in combination with any of the time-dependent, stationary, and eigenvalue solvers.

Postprocessing

Version 3.5a enhances the portability of graphics from COMSOL by supporting the GIF format for images and the animated GIF format for movies.

The versatility of the visualization capabilities is increased in this version and you can customize the existing color tables to create your own color schemes.

Finally, in order to check the status of the solution process, version 3.5a allows plotting while solving.



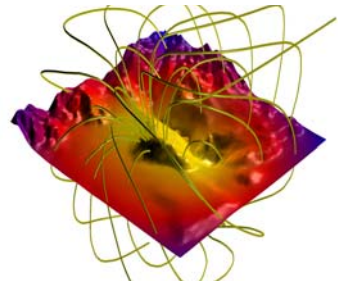
Plotting while solving allows for better monitoring of the solution process.

New Models

The COMSOL model libraries have been expanded with a variety of exciting new models illustrating the enhancements in COMSOL Multiphysics 3.5a. These new models are categorized below by disciple-specific module.

AC/DC MODULE:

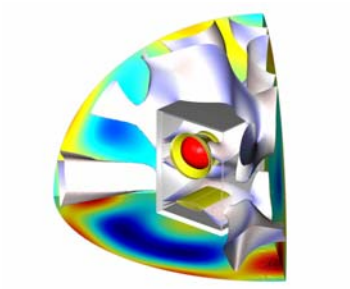
Simulation of the magnetic prospecting of iron ore deposits model in the AC/DC Module Model Library.



MODEL NAME	MODEL DESCRIPTION
planar transformer	Simulation of the electromagnetic fields in a planar transformer using ECAD geometry import.
magnetic prospecting	Simulation of the magnetic prospecting of iron ore deposits.

ACOUSTICS MODULE:

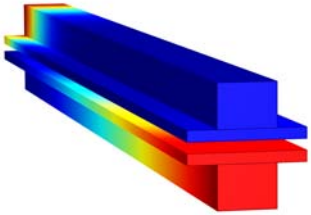
Isosurfaces of the sound pressure level in a simulation of a loudspeaker enclosure in the Acoustics Module Model Library.



MODEL NAME	MODEL DESCRIPTION
horn shape optimization	The shape of an initially conical, axisymmetric horn is optimized with respect to sound pressure level in the far field.
loudspeaker driver	Model of a loudspeaker driver that includes both an electromagnetic analysis of the voice coil and an acoustic-structure interaction analysis of the sound-generating diaphragm.
loudspeaker suspension	Simulation of the resistance and compliance of the suspension in a loudspeaker.
vented loudspeaker enclosure	Model of a boxed loudspeaker that allows for calculating the resulting sound pressure level in the room as a function of the frequency.

CHEMICAL ENGINEERING MODULE:

A fully coupled model of a solid oxide fuel cell unit cell in the Chemical Engineering Module Model Library.

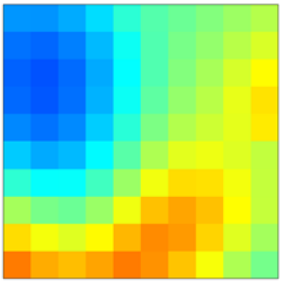


MODEL NAME	MODEL DESCRIPTION
steam reformer	Simulation of a steam reformer, serving a stationary fuel cell with hydrogen.
diesel particulate filter 3D	Model that studies the averaged flow field, concentration and temperature distribution in a homogenized model of a diesel particulate filter.
microreactor optimization	Optimization of the reaction rate in a catalytic microreactor.
thermal dispersion	Parameter estimation of the thermal dispersion coefficients of a packed bed.
sofc unit cell	Analysis of the current density distribution in a solid oxide fuel cell unit cell.
freeze drying	Model of the process of sublimation of pure water ice in a vial.
rechargeable lithium-ion battery	Simulation of the transient charge and discharge performance of a rechargeable Li-ion battery.
polymerization multijet	Simulation of polymerization in a multijet reactor.

MODEL NAME	MODEL DESCRIPTION
copper deposition in a trench	Model of the electroplating of copper in a microcavity typically found in the plating of copper onto circuit boards.
packed bed reactor	This model presents a simple and fast alternative for studying macro- and micro-mass balances in packed beds and other heterogeneous rectors with bimodal pore distribution.
boiling water	Simulation of the boiling of water solved with the phase field method.
droplet breakup 3D	Model that studies in detail how droplets in an emulsion can be created.
phase separation	Benchmark model of how two initially mixed, immiscible phases are separated into pure components.
two phase turbulent flow	Turbulent two-phase flow problem solved with the phase field method.

EARTH SCIENCE MODULE:

Estimating the hydraulic-conductivity field in an aquifer using inverse modeling and experimental data in the Earth Science Module.



MODEL NAME	MODEL DESCRIPTION
aquifer characterization	Estimating the hydraulic-conductivity field in an aquifer using inverse modeling and experimental data.
forchheimer flow	The resistance to flow in open porous structures, like packed beds, is governed by both laminar and turbulent effects. The Forchheimer equation takes this into account.
aquifer water table	Instead of being assumed, the shape of the water table is computed in this model to correctly model groundwater flow in an aquifer.

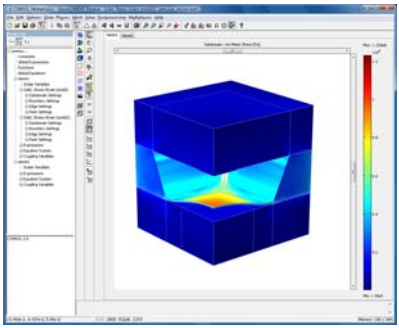
HEAT TRANSFER MODULE:

The light bulb model exemplifies surface-to-surface radiation and non-isothermal flow in the Heat Transfer Model Library.

MODEL NAME	MODEL DESCRIPTION
light bulb	Axisymmetric analysis of a light bulb including surface-to-surface radiation, and free convection.
displacement ventilation	This example examines the performance of a displacement ventilation system in a room, by modeling turbulent flow coupled to heat transfer.

MEMS MODULE:

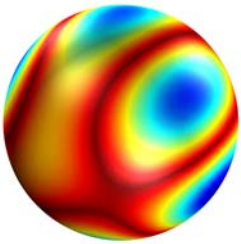
The pressure sensor model simulates the measuring of pressure changes through changes in capacitance.



MODEL NAME	MODEL DESCRIPTION
twophase fsi	Fluid-structure interaction for a fluid containing two phases.
pressure sensor 3D	Simulation of a sensor that measures pressure changes through changes in capacitance.
thin film baw resonator	Simulation of a thin film BAW resonator.
tunable piezoelectric actuator	Simulation of the frequency response of an actuator coupled to an external tuning circuit described using a SPICE netlist.

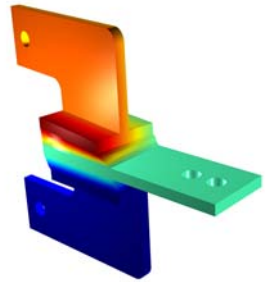
RF MODULE:

Simulation of the Schumann resonance frequencies model in the RF Module Model Library.



MODEL NAME	MODEL DESCRIPTION
pcb microwave filter with stress	Simulation of a microstrip filter using ECAD import.
conical antenna with circuit	Analysis of a conical antenna coupled with an external circuit.
periodic boundary condition	Updated tutorial model showing how to set up Floquet periodic boundary conditions.
shape optimization dipole antenna	Optimization of the length and diameter of a dipole antenna to obtain a certain input impedance value.
schumann resonance	Simulation of the Schumann resonance frequencies.
waveguide optimization	This tutorial model shows how to perform S-parameter sensitivity analysis and optimization of a 90-degree microwave waveguide bend.

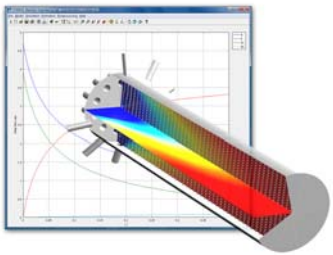
Simulation of a viscoelastic damping element for reduction of seismic and wind-induced vibrations in tall buildings.



MODEL NAME	MODEL DESCRIPTION
viscoplastic solder joints	This model studies viscoplastic creep in solder joints under thermal loading using the Anand viscoplasticity model.
thermal viscoelastic tube	The model studies the temperature effects on the viscoelastic stress relaxation in a generalized Maxwell material with four branches.
viscoelastic damper	This model studies a damper intended for reduction of wind-induced and seismic vibrations in buildings and other tall structures.
contact cellular screen	Contact modeling of a cell phone display subjected to a load.
aluminum extrusion fsi	Fluid-structure interaction of an aluminum extrusion process, including thermal-structure and thermal-fluid couplings.
elbow bracket	Tutorial model that performs various structural simulations of an elbow bracket of steel.

MODEL NAME	MODEL DESCRIPTION
rail steel	This example studies the elastoacoustic effect, a change in the speed of elastic waves propagating in a structure that is undergoing static elastic deformations.
rotating blade	The eigenfrequencies of a rotating blade are studied in this benchmark model.

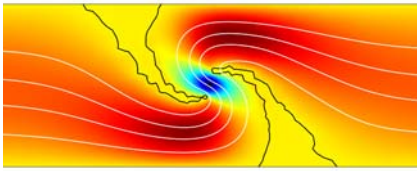
Simulation of polymerization in a multijet reactor model in the Reaction Engineering Lab Model Library.



MODEL NAME	MODEL DESCRIPTION
tankinseries control	The model illustrated here involves a series of three consecutive tank reactors including a feedback control to keep the concentration at the outlet to a prescribed level.
polymerization multijet	Simulation of polymerization in a multijet reactor.

COMSOL MULTIPHYSICS:

Fluid flow topology optimization model in the COMSOL Multiphysics Model Library.



MODEL NAME	MODEL DESCRIPTION
flywheel profile	Optimizing the radial thickness profile of a flywheel with respect to the objective of obtaining a radial stress distribution that is as even as possible.
loaded knee	Minimum compliance optimization of a given amount of material forming an L-shaped frame.
reversed flow	Minimizing the fluid flow in a microchannel by topology optimization.
spice parameter extraction	The IV-characteristics from the Semiconductor Diode model are used to extract the model parameters for the SPICE model of a diode.
mast diagonal mounting sensitivity	Sensitivity analysis is used to predict what effect changing geometrical parameters of a communication mast part has on its overall stiffness.