COMSOL® Software – Release Highlights History

COMSOL Multiphysics® Software					
Geometry and Mesh	4.X	5.0–1	5.2	5.3	5.4
Virtual geometry operations	✓	✓	✓	✓	✓
Image import	✓	✓	✓	✓	✓
STL export	✓	✓	✓	✓	✓
NASTRAN® program mesh export	✓	✓	✓	✓	✓
Loft, fillet, chamfer, thickening, and midsurfacing with the Design Module		✓	✓	✓	✓
New tetrahedral mesher			✓	✓	✓
Element quality optimizer			✓	✓	✓
Performance improvements for large models by a factor of 5 or more				✓	✓
Automatic removal of geometric detail for more flexible meshing				✓	✓
Automatic pyramid transitions from hex to tet elements				✓	✓
Parametric models with user-defined functions				✓	✓
Extended mesh adaption and refinement for all element types and imported meshes					✓
Modeling Tools	4.X	5.0–1	5.2	5.3	5.4
Coordinate-based selections	✓	✓	✓	✓	✓
Automatic curvilinear coordinate systems	✓	✓	✓	✓	✓
New COMSOL Desktop® environment	✓	✓	✓	✓	✓
Material sweeps		✓	✓	✓	✓
Open and inspect MPH-files without add-on licenses		✓	✓	✓	✓
Autocomplete for parameters, variables, and equations			✓	✓	✓
Model methods for programming Model Builder tasks				✓	✓
PDE modeling with the boundary element method (BEM)				✓	✓
Copy-paste physics interfaces or model components				✓	✓
Model methods in the model tree with input arguments				✓	✓
Colored selections for geometry and physics					✓
Multiple Parameter nodes and Parameter Cases					✓
Node groups for organizing the model tree					✓
Custom settings windows					✓
Studies and Solvers	4.X	5.0–1	5.2	5.3	5.4
Time-dependent adaptive meshing	✓	✓	✓	✓	✓
Automatic remeshing	✓	✓	✓	✓	✓
Cluster sweeps and cloud computing	✓	✓	✓	✓	✓
Multiparameter sweeps	✓	✓	✓	✓	✓
Smoothed AMG solver			✓	✓	✓

*4.X includes 4.2, 4.2a, 4.3, 4.3a, 4.3b, and 4.4 versions.
*5.0–1 includes 5.0, 5.0.1, and 5.1 versions.
*5.2 includes 5.2 and 5.2a versions.
*5.3 includes 5.3 and 5.3a versions.

Optimized domain decomposition solver			✓	✓	✓
Model reduction based on modal analysis and asymptotic waveform evaluation (AWE)				✓	✓
Algebraic multigrid (AMG) solver for CFD				✓	✓
Combine two solutions into one				✓	✓
Direct and iterative solver suggestions				✓	✓
Several times faster solving in the Windows® operating system					✓
Parameter sweeps over Parameter Cases					✓
Optimization for parametric sweeps with derivative-free methods					✓
Results and Visualization	**4.X**	**5.0–1**	**5.2**	**5.3**	**5.4**
Report Generator	✓	✓	✓	✓	✓
Interactive slice and isosurface plots	✓	✓	✓	✓	✓
Reports on Microsoft® Word® program format	✓	✓	✓	✓	✓
2D and 3D annotations			✓	✓	✓
1D annotations			✓	✓	✓
Annotations with LaTeX formatting			✓	✓	✓
VTK format export			✓	✓	✓
6 new color tables			✓	✓	✓
Selections for plotting a subset of the geometry				✓	✓
1D plots with two different quantities on y-axes				✓	✓
Step between solutions using toolbar buttons				✓	✓
3Dconnexion® SpaceMouse® device support				✓	✓
Cividis color table for people with color vision deficiency				✓	✓
Save plots in models for faster rendering				✓	✓
Export animations in the WebM video format				✓	✓
Arrows on streamlines					✓
Evaluation groups					✓
glTF™ file export					✓
Report templates					✓
Application Builder	**4.X**	**5.0–1**	**5.2**	**5.3**	**5.4**
Application Builder for converting models to applications		✓	✓	✓	✓
Send email from applications		✓	✓	✓	✓
60 example applications in the Application Libraries			✓	✓	✓
Interactive data picking in graphics				✓	✓
OS command line arguments					✓
Local declarations and methods in forms					✓
NEW Product: COMSOL Compiler™					✓

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COMSOL Server™ Product	4.X	5.0–1	5.2	5.3	5.4
NEW Product: COMSOL Server™		✓	✓	✓	✓
Run applications with COMSOL Client for Windows® operating system or web browsers		✓	✓	✓	✓
Allow coworkers and customers worldwide to run COMSOL applications		✓	✓	✓	✓
Custom COMSOL Server™ themes for branding			✓	✓	✓
Centralized cluster settings				✓	✓
Usage log text file				✓	✓
Automatic login to COMSOL Server™				✓	✓
Live search in the Application Library page					✓
Send notifications to users as email					✓

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ELECTROMAGNETICS	4.X	5.0–1	5.2	5.3	5.4
Lumped ports and R,L,C,S parameter matrices	✓	✓	✓	✓	✓
Multiphysics interface for electrostatic-structural interactions	✓	✓	✓	✓	✓
Multiphysics interface for piezoresistivity	✓	✓	✓	✓	✓
Inductively coupled and microwave plasmas	✓	✓	✓	✓	✓
NEW Product: Wave Optics Module	✓	✓	✓	✓	✓
NEW Product: Semiconductor Module	✓	✓	✓	✓	✓
Nonlinear magnetic material library with 165 materials	✓	✓	✓	✓	✓
Multiphysics interface for laser heating	✓	✓	✓	✓	✓
Multiphysics interface for optoelectronics		✓	✓	✓	✓
NEW Product: Ray Optics Module		✓	✓	✓	✓
Coil analysis tools		✓	✓	✓	✓
Optical materials database with over 1400 materials		✓	✓	✓	✓
Multiphysics interface for ray heating		✓	✓	✓	✓
User-defined materials written in C			✓	✓	✓
Smith plots			✓	✓	✓
Magnetic vector hysteresis material model			✓	✓	✓
Optical aberration plots			✓	✓	✓
Electrostatics based on the boundary element method (BEM)				✓	✓
Accelerated computation of capacitance matrix and other lumped matrices				✓	✓
Part Library with waveguides, surface-mount footprints, and SMA connectors				✓	✓
Photometric data file import for ray optics				✓	✓
Schrödinger equation interfaces				✓	✓
Revolutionary new method for capacitively coupled plasma (CCP) simulations				✓	✓
Hybrid boundary-element–finite-element method (BEM-FEM) for magnetic field analysis				✓	✓
Soft magnet material model of permanent magnets				✓	✓
Adaptive frequency sweep for high-frequency electromagnetics				✓	✓

ELECTROMAGNETICS	4.X	5.0–1	5.2	5.3	5.4
Library of more than 60 RF and microwave substrate materials from Rogers Corporation				✓	✓
Electric currents in layered shells					✓
Part Library for coils and magnetic cores					✓
Far-field analysis for transient models					✓
High-definition Part Library for ray optics					✓
Optical dispersion models for ray optics					✓
New algorithm for computing ray intensity and power					✓
Wavelength distributions at ray releases for polychromatic light					✓
Multiphysics interface for Schrödinger-Poisson Equation					✓

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HEAT TRANSFER	4.X	5.0–1	5.2	5.2	5.4
Multilayered shells	✓	✓	✓	✓	✓
Fans and grilles	✓	✓	✓	✓	✓
Solar irradiation	✓	✓	✓	✓	✓
Moist air and condensation	✓	✓	✓	✓	✓
Multiwavelength radiation	✓	✓	✓	✓	✓
Phase change	✓	✓	✓	✓	✓
Thermal contact with surface roughness	✓	✓	✓	✓	✓
Multiphysics interface for the thermoelectric effect	✓	✓	✓	✓	✓
Bioheating with damage integral analysis	✓	✓	✓	✓	✓
Nonisothermal flow in porous media		✓	✓	✓	✓
Algebraic turbulence models		✓	✓	✓	✓
Multiphysics interface for the Marangoni effect		✓	✓	✓	✓
Meteorological database for ambient conditions			✓	✓	✓
Multiphysics interface for heat and moisture transport			✓	✓	✓
Surface-to-surface radiation symmetry for perpendicular planes				✓	✓
Irreversible transformations in solids				✓	✓
New Moisture Flow multiphysics coupling				✓	✓
New inflow boundary condition based on known upstream conditions				✓	✓
Beer-Lambert law for absorption of light in weakly absorbing media				✓	✓
Mixed diffuse-specular reflections and semitransparent surfaces					✓
Heat transfer in thin, layered structures					✓
Arbitrary number of spectral bands for surface-to-surface radiation					✓
Light-diffusion equation interface					✓
Thermal insulation for interior boundaries					✓
Ambient Thermal Properties tool					✓
Dedicated plots for temperature discontinuities					✓

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STRUCTURAL MECHANICS	4.X	5.0–1	5.2	5.3	5.4
Prestressed analysis	✓	✓	✓	✓	✓
Thin-film damping for MEMS	✓	✓	✓	✓	✓
NEW Product: Geomechanics Module	✓	✓	✓	✓	✓
Multiphysics interface for MEMS thermoelasticity	✓	✓	✓	✓	✓
Load cases	✓	✓	✓	✓	✓
Membranes	✓	✓	✓	✓	✓
Cyclic and Floquet periodicity	✓	✓	✓	✓	✓
NEW Product: Nonlinear Structural Materials Module	✓	✓	✓	✓	✓
NEW Product: Fatigue Module	✓	✓	✓	✓	✓
Bolt pretension	✓	✓	✓	✓	✓
NEW Product: Multibody Dynamics Module	✓	✓	✓	✓	✓
Rotordynamic forces	✓	✓	✓	✓	✓
Multiphysics interface for hygroscopic swelling		✓	✓	✓	✓
Nonlinear elastic materials		✓	✓	✓	✓
Orthotropic, anisotropic, and hyperelastic membranes		✓	✓	✓	✓
Multiphysics interfaces for multibody dynamics with heat transfer and acoustics		✓	✓	✓	✓
NEW Product: Rotordynamics Module			✓	✓	✓
Multiphysics interface for thermoelastic damping in MEMS			✓	✓	✓
User-defined materials written in C			✓	✓	✓
Adhesion and decohesion for mechanical contact			✓	✓	✓
Multiphysics interface for magnetostriction			✓	✓	✓
New plasticity material models			✓	✓	✓
Stress linearization evaluation of membrane, bending, and peak stress				✓	✓
Automatic suppression of rigid body motion				✓	✓
Computation of safety factors for 12 safety criteria				✓	✓
Frequency response of mechanical contact models				✓	✓
Material models for porous plasticity				✓	✓
Vibration fatigue analysis				✓	✓
Rotor bearing system simulator application				✓	✓
Shape memory alloy (SMA) material models				✓	✓
Generalized multiphysics interface for fluid-structure interaction (FSI)				✓	✓
Bolt thread contact modeling				✓	✓
Solid-beam connection in 3D models				✓	✓
Generalized plane strain formulation				✓	✓
Cam-Follower condition for multibody dynamics				✓	✓
Lumped Mechanical System interface				✓	✓
Ball and roller bearings for rotordynamics simulations				✓	✓
NEW Product: Composite Materials Module					✓
Composite material analysis based on layerwise and equivalent single layer theory					✓

STRUCTURAL MECHANICS	4.X	5.0–1	5.2	5.3	5.4
Response spectrum analysis					✓
Representative volume elements (RVE) for homogenization of periodic materials					✓
Shell interface for axisymmetric analysis					✓
Multiphysics interface for fluid-structure interaction with shells , membranes, and composite materials					✓
Multiphysics interface for fluid-structure interaction with structural assemblies and multibody dynamics					✓
Multiphysics interface for acoustic-structure interaction for composite materials					✓
Multiphysics interface for thermal expansion in composite materials					✓
Multiphysics interface for Joule heating in composite materials					✓
Multiphysics interface for thermoelectric effect in composite materials					✓
Activation of material for additive manufacturing					✓
Flexible formulation for rigid connectors and attachments					✓
Mullins effect for hyperelastic materials					✓
Continuum-based damage model for brittle materials					✓
New modeling options for hyperelastic materials with low compressibility					✓
Mean stress correction for fatigue analysis based on the Goodman, Gerber, and Soderberg methods					✓
Multiphysics interface for electromechanics with structural FEM and electrostatics BEM					✓

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ACOUSTICS	4.X	5.0–1	5.2	5.3	5.4
Multiphysics interface for acoustic-piezo interactions	✓	✓	✓	✓	✓
Multiphysics interface for acoustic-shell interactions	✓	✓	✓	✓	✓
Multiphysics interface for poroelastic waves	✓	✓	✓	✓	✓
Multiphysics interface for thermoviscous acoustic-solid interactions	✓	✓	✓	✓	✓
Multiphysics interface for pipe acoustics	✓	✓	✓	✓	✓
Multiphysics interface for membrane-acoustic interactions	✓	✓	✓	✓	✓
Multiphysics interface for thermoviscous acoustic-shell interactions	✓	✓	✓	✓	✓
Aeroacoustics with linearized Euler equations	✓	✓	✓	✓	✓
Ray acoustics		✓	✓	✓	✓
Aeroacoustics with linearized Navier-Stokes equations		✓	✓	✓	✓
Octave plots			✓	✓	✓
Discontinuous Galerkin method for ultrasound with background flow			✓	✓	✓
Directivity plots			✓	✓	✓
Perfectly matched layers (PMLs) for pressure acoustics in the time domain				✓	✓
Beam width calculations for far-field plots				✓	✓
Thermoviscous acoustics in the time domain				✓	✓
Hybrid BEM-FEM for acoustics and acoustic-structure interactions				✓	✓
Impulse response analysis for ray acoustics				✓	✓

ACOUSTICS	4.X	5.0–1	5.2	5.3	5.4
Port boundary conditions for pressure acoustics					✓
Nonlinear acoustics Westervelt model for high sound pressure levels					✓
Atmosphere and ocean attenuation material models					✓
Multiphysics BEM-FEM coupling to thermoviscous acoustics and poroelastic waves					✓
Multiphysics BEM-FEM coupling to poroelastic waves					✓

See page 25 for more details

FLUID FLOW	4.X	5.0–1	5.2	5.3	5.4
High Mach number flow	✓	✓	✓	✓	✓
NEW Product: Microfluidics Module	✓	✓	✓	✓	✓
k-omega turbulence model	✓	✓	✓	✓	✓
Euler-Euler two-phase flow	✓	✓	✓	✓	✓
Slip flow	✓	✓	✓	✓	✓
NEW Product: Pipe Flow Module	✓	✓	✓	✓	✓
Automatic boundary layer meshing	✓	✓	✓	✓	✓
Turbulent mixing and reacting flow	✓	✓	✓	✓	✓
SST turbulence	✓	✓	✓	✓	✓
Thin screens	✓	✓	✓	✓	✓
NEW Product: Molecular Flow Module	✓	✓	✓	✓	✓
Wall surface roughness for turbulent flow	✓	✓	✓	✓	✓
Anisotropic porous media flow	✓	✓	✓	✓	✓
NEW Product: Mixer Module	✓	✓	✓	✓	✓
Algebraic turbulence models		✓	✓	✓	✓
Turbulence with grilles and fans		✓	✓	✓	✓
Cavitation for thin film flow		✓	✓	✓	✓
3D laminar flow to 1D pipe flow connection		✓	✓	✓	✓
Coupled porous media and turbulent flow		✓	✓	✓	✓
Three-phase laminar flow			✓	✓	✓
Easy definition of gravity and buoyancy effects			✓	✓	✓
v2-f turbulence model				✓	✓
Automatic wall treatment for turbulent flow				✓	✓
Algebraic multigrid (AMG) solver for CFD				✓	✓
Transport of diluted species in porous media and fractures				✓	✓
Generalized multiphysics interface for fluid-structure interaction (FSI)				✓	✓
Inlet boundary conditions for fully developed turbulent flow				✓	✓
Realizable k-ε turbulence model				✓	✓
Buoyancy-driven turbulence				✓	✓

FLUID FLOW	4.X	5.0–1	5.2	5.3	5.4
All turbulence models made available for multiphase flow				✓	✓
Rotating machinery interfaces made available for all flow interfaces				✓	✓
Large eddy simulation (LES) for single-phase flow					✓
Phase transport in free and porous media					✓
Fully developed flow at inlets and outlets for turbulent flow					✓
Non-Newtonian yield-stress fluids: Bingham-Papanastasiou, Casson-Papanastasiou models, amd Herschel-Bulkley-Papanastasiou					✓

See page 27 for more details

CHEMICAL	4.X	5.0–1	5.2	5.3	5.4
Surface reactions	✓	✓	✓	✓	✓
Reacting flow	✓	✓	✓	✓	✓
AC impedance spectroscopy	✓	✓	✓	✓	✓
NEW Product: Electrodeposition Module	✓	✓	✓	✓	✓
NEW Product: Corrosion Module	✓	✓	✓	✓	✓
NEW Product: Electrochemistry Module	✓	✓	✓	✓	✓
Multiscale simulations for packed bed reactors		✓	✓	✓	✓
Equilibrium reactions		✓	✓	✓	✓
Multiphysics interface for hygroscopic swelling with species transport		✓	✓	✓	✓
Nonspherical catalytic pellet shapes			✓	✓	✓
Thin insulating sheets for corrosion simulations			✓	✓	✓
Nernst-Planck-Poisson equations interface				✓	✓
Electrophoretic transport interface				✓	✓
Primary and secondary current distribution based on the boundary element method (BEM)				✓	✓
A built-in thermodynamic properties library				✓	✓
Link between Reaction Engineering interface and thermodynamic property packages				✓	✓
Electrode reactions on thin electrode surfaces fully immersed in electrolyte				✓	✓
New Lithium-Ion Battery Designer application for optimizing batteries for specific use cases				✓	✓
Updated Thermodynamics interface					✓
Partition condition for prescribing the ratio between concentrations in two adjacent phases					✓
Lumped battery interface					✓
Stress and strain in electrode particles due to lithium intercalation					✓
Equivalent circuit modeling of batteries					✓
Level set interface for corrosion modeling					✓

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OPTIMIZATION	4.X	5.0–1	5.2	5.3	5.4
Parameter optimization	✓	✓	✓	✓	✓
Design optimization	✓	✓	✓	✓	✓
Gradient-based and derivative-free optimization study	✓	✓	✓	✓	✓
Multianalysis optimization		✓	✓	✓	✓
New least square fitting method			✓	✓	✓
Density model feature for topology optimization					✓
Combined parametric sweeps with derivative-free optimization					✓

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PARTICLE TRACING	4.X	5.0–1	5.2	5.3	5.4
NEW Product: Particle Tracing Module	✓	✓	✓	✓	✓
Secondary emission	✓	✓	✓	✓	✓
Particle-particle interactions	✓	✓	✓	✓	✓
Particle-field and fluid-particle interactions	✓	✓	✓	✓	✓
Space-charge limited emission		✓	✓	✓	✓
Particle-matter interactions			✓	✓	✓
Periodic boundary condition for particle tracing				✓	✓
Rotating frames for particle tracing				✓	✓
Symmetry boundary condition for particle tracing				✓	✓
Accumulators for velocity reinitialization to compute, for example, spatial density of collisions					✓

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INTERFACING	4.X	5.0–1	5.2	5.3	5.4
NEW Product: LiveLink™ *for* AutoCAD®	✓	✓	✓	✓	✓
LiveLink™ *for* SOLIDWORKS®: one-window interface	✓	✓	✓	✓	✓
NEW Product: LiveLink™ *for* PTC® Creo® Parametric™	✓	✓	✓	✓	✓
NEW Product: LiveLink™ *for* Excel®	✓	✓	✓	✓	✓
NEW Product: ECAD Import Module	✓	✓	✓	✓	✓
NEW Product: LiveLink™ *for* Solid Edge®	✓	✓	✓	✓	✓
LiveLink™ *for* Inventor®: one-window interface	✓	✓	✓	✓	✓
NEW Product: LiveLink™ *for* Revit®	✓	✓	✓	✓	✓
NEW Product: Design Module	✓	✓	✓	✓	✓

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COMSOL® Software – Release Details History

COMSOL MULTIPHYSICS® PLATFORM AND HARDWARE SUPPORT	4.X	5.0–1	5.2	5.3	5.4
General Windows® and Linux® operating systems and macOS support	✓	✓	✓	✓	✓
Run applications on all major web browsers		✓	✓	✓	✓
macOS 10.10–10.14 Sierra operating system support		✓	✓	✓	✓
Windows® 10 operating system support		✓	✓	✓	✓
3Dconnexion® SpaceMouse® device support				✓	✓
NEW Product: COMSOL Compiler™					✓

COMSOL MULTIPHYSICS® MESH AND GEOMETRY	4.X	5.0–1	5.2	5.3	5.4
Virtual geometry operations	✓	✓	✓	✓	✓
Parametric surfaces	✓	✓	✓	✓	✓
Digital elevation model (DEM) import	✓	✓	✓	✓	✓
Image import	✓	✓	✓	✓	✓
Interpolation curves	✓	✓	✓	✓	✓
STL export	✓	✓	✓	✓	✓
3D cross-section work planes	✓	✓	✓	✓	✓
Automatic curvilinear coordinate systems	✓	✓	✓	✓	✓
Boolean operations on surfaces	✓	✓	✓	✓	✓
NASTRAN® program import	✓	✓	✓	✓	✓
NASTRAN® program mesh export	✓	✓	✓	✓	✓
Solid operations on imported meshes		✓	✓	✓	✓
Loft, fillet, chamfer, thickening, and midsurfacing with the new Design Module		✓	✓	✓	✓
Geometry parts		✓	✓	✓	✓
New tetrahedral mesher			✓	✓	✓
Mesh parts			✓	✓	✓
Element quality optimizer			✓	✓	✓
STL import with multiple solids			✓	✓	✓
Performance improvements for large models by a factor of 5 or more				✓	✓
Coordinate systems defined by work planes and geometry orientations				✓	✓
Combined coordinate systems in physics				✓	✓
Automatic removal of geometric detail for more flexible meshing				✓	✓
Extrude in two directions				✓	✓
Line segment tool				✓	✓
2D selections from 3D selections using cross sections				✓	✓
Geometry part variants				✓	✓
Automatic pyramid transitions from hex to tet elements				✓	✓
Mesh size expressions				✓	✓
Mesh adaptation integrated with mesh sequence				✓	✓

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COMSOL MULTIPHYSICS® MESH AND GEOMETRY	4.X	5.0–1	5.2	5.3	5.4
Five new mesh quality measures				✓	✓
Automatic detection of straight and planar edges of imported meshes				✓	✓
Option for switching off mesh rendering				✓	✓
Projection coupling operators for all element types				✓	✓
Parametric models with user-defined functions				✓	✓
Automatic removal of thin domains for more flexible meshing				✓	✓
Element size expressions based on physics and materials				✓	✓
Selections stored in the COMSOL mesh file format (.mphbin and .mphtxt)				✓	✓
Isolated vertices and edges for mapped meshes				✓	✓
Mesh refinement for all element types					✓
Collapse narrow face regions for easier meshing					✓
Selection-based automatic removal of geometric detail					✓
Extended mesh adaption with element coarsening and mesh modifications					✓
Physics-controlled meshing controlled per physics interface					✓
Swept meshing of domains with isolated vertices and edges					✓
Convert, Refine, and Adapt operations for imported meshes					✓
Faster boundary-layer meshing					✓

COMSOL MULTIPHYSICS® MODELING TOOLS	4.X	5.0–1	5.2	5.3	5.4
Coordinate-based selections	✓	✓	✓	✓	✓
Boundary PDEs and distributed ODEs	✓	✓	✓	✓	✓
New COMSOL Desktop®	✓	✓	✓	✓	✓
Multiphysics node in the Model Builder	✓	✓	✓	✓	✓
Hover-and-click selections	✓	✓	✓	✓	✓
Global materials		✓	✓	✓	✓
Material sweeps		✓	✓	✓	✓
Open and inspect MPH-files without add-on licenses		✓	✓	✓	✓
Search tool for models and applications		✓	✓	✓	✓
Table sort		✓	✓	✓	✓
Save MPH-file if license server connection is lost			✓	✓	✓
Release licenses dynamically			✓	✓	✓
Autocomplete for parameters, variables, and equations			✓	✓	✓
Automatic reconnect for client-server			✓	✓	✓
Optimized save for MPH-files			✓	✓	✓
Multiphysics window for manually combining physics interfaces			✓	✓	✓
Generalized 3D interpolation functions			✓	✓	✓
Cylindrical sector selections				✓	✓
Model methods for programming Model Builder tasks				✓	✓

COMSOL MULTIPHYSICS® MODELING TOOLS	4.X	5.0–1	5.2	5.3	5.4
Faster save and load of MPH-files				✓	✓
PDE modeling with the boundary element method (BEM)				✓	✓
Copy-paste physics interfaces or model components				✓	✓
Model methods in the model tree with input arguments				✓	✓
Generalized moving mesh functionality				✓	✓
Variables for matrix operations				✓	✓
Application for cluster setup validation				✓	✓
Counter for the number of selections				✓	✓
Colored selections for geometry and physics					✓
Multiple Parameter nodes					✓
Parameter Cases					✓
Node groups for organizing the model tree					✓
Model and application comparison					✓
Import and export of preferences					✓
Multiselection in Parameters and Variables tables					✓
Custom Settings windows					✓

COMSOL MULTIPHYSICS® STUDIES AND SOLVERS	4.X	5.0–1	5.2	5.3	5.4
Time-dependent adaptive meshing	✓	✓	✓	✓	✓
Automatic remeshing	✓	✓	✓	✓	✓
Double dogleg nonlinear solver	✓	✓	✓	✓	✓
Cluster Sweep and Batch Sweep	✓	✓	✓	✓	✓
Multiparameter sweeps	✓	✓	✓	✓	✓
Cloud computing with Amazon EC2™	✓	✓	✓	✓	✓
Sensitivity study	✓	✓	✓	✓	✓
CAD assembly multiphysics simulations		✓	✓	✓	✓
Eigenfrequency interval search		✓	✓	✓	✓
Selections for solution data			✓	✓	✓
Smoothed AMG solver			✓	✓	✓
Optimized domain decomposition solver			✓	✓	✓
Nonreflecting absorbing layers for time-dependent wave simulations			✓	✓	✓
Specify the number of sockets used on a multisocket computer			✓	✓	✓
Algebraic multigrid (AMG) solver for CFD				✓	✓
Adaptation integrated with meshing sequences and error estimation				✓	✓
Fast solver for the boundary element method (BEM)				✓	✓
Hybrid solver for finite element and boundary element methods				✓	✓
Combine two solutions into one				✓	✓
Direct and iterative solver suggestions				✓	✓

COMSOL MULTIPHYSICS® STUDIES AND SOLVERS	4.X	5.0–1	5.2	5.3	5.4
Model reduction based on modal analysis and asymptotic waveform evaluation (AWE)				✓	✓
Parallelized smoothed aggregation algebraic multigrid (SA-AMG) solver				✓	✓
Remove selections when combining solutions				✓	✓
Compute weighted sums of solutions				✓	✓
Auxiliary parameter sweeps for eigenfrequency and eigenvalue studies				✓	✓
Starting UI-defined Batch Sweep or Cluster Sweep from a batch command				✓	✓
Built-in support for PBS-based schedulers in cluster computing				✓	✓
Several times faster solving in the Windows® operating system					✓
Parameter sweeps over Parameter Cases					✓
Optimization for parametric sweeps with derivative-free methods					✓
Mesh refinement level parameter for adaptive meshing					✓
New TFQMR iterative linear solver					✓

COMSOL MULTIPHYSICS® RESULTS AND VISUALIZATION	4.X	5.0–1	5.2	5.3	5.4
Report Generator	✓	✓	✓	✓	✓
Interactive slice and isosurface plots	✓	✓	✓	✓	✓
Join data sets	✓	✓	✓	✓	✓
Reports on Microsoft® Word® program format	✓	✓	✓	✓	✓
Comet tail plots	✓	✓	✓	✓	✓
STL export of isosurfaces	✓	✓	✓	✓	✓
Text-based search for variables in results	✓	✓	✓	✓	✓
Spectrum color table		✓	✓	✓	✓
Contour tube plot		✓	✓	✓	✓
Visualize on grid outside computational mesh		✓	✓	✓	✓
Point trajectories plot		✓	✓	✓	✓
Array visualization for periodic solutions		✓	✓	✓	✓
2D and 3D annotations			✓	✓	✓
1D annotations			✓	✓	✓
Annotations with LaTeX formatting			✓	✓	✓
VTK format export			✓	✓	✓
6 new color tables			✓	✓	✓
Multiple expressions in Derived Values			✓	✓	✓
Results parameters			✓	✓	✓
Global expressions for Slice, Arrow, and Cut Plane positions			✓	✓	✓
Selections for plotting a subset of the geometry				✓	✓
1D plots with two different quantities on y-axes				✓	✓
Step between solutions using toolbar buttons				✓	✓

COMSOL MULTIPHYSICS® RESULTS AND VISUALIZATION	4.X	5.0–1	5.2	5.3	5.4
Streamline surface plot				✓	✓
Units shown in geometry plots and color legends				✓	✓
Option for switching off mesh rendering				✓	✓
Preview evaluation plane for far-field and directivity plots				✓	✓
Cividis color table for people with color vision deficiency				✓	✓
Save plots in models for faster rendering				✓	✓
Export animations in the WebM video format				✓	✓
Interactive control of center of rotation				✓	✓
Rotating the camera about the x-, y-, and z-axes				✓	✓
Filters on 1D plots				✓	✓
Plot First and Plot Last buttons				✓	✓
Hardware-accelerated image generation for image export				✓	✓
Arrows on streamlines					✓
Evaluation groups					✓
Report templates					✓
Extrusion data sets					✓
Surface slit plots for visualizing discontinuous fields					✓
glTF™ file export					✓
API functionality for custom plots					✓
New Graphics toolbar buttons					✓
Faster rendering for large plots					✓
New lighting model with improved quality of 3D plots with Scene Light					✓

COMSOL MULTIPHYSICS® APPLICATION BUILDER	4.X	5.0–1	5.2	5.3	5.4
Application Builder		✓	✓	✓	✓
Convert model to application		✓	✓	✓	✓
20 example applications in Application Libraries		✓	✓	✓	✓
Send email from applications		✓	✓	✓	✓
Support for applications using LiveLink™ *for* Excel®		✓	✓	✓	✓
Enabling disabling of form objects from methods		✓	✓	✓	✓
60 example applications in Application Libraries			✓	✓	✓
Editor tools			✓	✓	✓
Dynamic graphics updates			✓	✓	✓
Modifying the user interface at runtime			✓	✓	✓
Autocompletion for application objects			✓	✓	✓
Video and hyperlink form objects			✓	✓	✓
Unit sets for centralized unit control			✓	✓	✓
Interactive data picking in graphics				✓	✓

COMSOL MULTIPHYSICS® APPLICATION BUILDER	4.X	5.0–1	5.2	5.3	5.4
Data access in the Application Builder settings				✓	✓
Improved toolbar for applications in a web browser				✓	✓
Data access for physics interfaces				✓	✓
Horizontal radio buttons				✓	✓
OS command line arguments					✓
Flat-style buttons					✓
Local declarations and methods in forms					✓
Unified model methods and application methods					✓

COMSOL SERVER™	4.X	5.0–1	5.2	5.3	5.4
NEW Product: COMSOL Server™		✓	✓	✓	✓
Run applications with COMSOL Client for Windows®		✓	✓	✓	✓
Run applications with any major web browser		✓	✓	✓	✓
Allow coworkers and customers to run COMSOL applications		✓	✓	✓	✓
Fast launch of applications, application prelaunching		✓	✓	✓	✓
Configure for one application			✓	✓	✓
Reconnect to application for lost connections			✓	✓	✓
Custom COMSOL Server™ themes for branding			✓	✓	✓
Power user role for user accounts			✓	✓	✓
Centralized cluster settings				✓	✓
Servers and Sessions view in the Monitor page				✓	✓
Automatic migration of preferences from previous installations				✓	✓
Usage log text file				✓	✓
Reverse proxy support				✓	✓
COMSOL Client login with Windows® Authentication, Active Directory®, or LDAP				✓	✓
Current license and product usage display				✓	✓
Upload multiple applications at the same time				✓	✓
Automatic login to COMSOL Server™				✓	✓
Edit description and thumbnail image in the COMSOL Server™ web interface				✓	✓
Modify and test login configuration in the COMSOL Server™ web interface				✓	✓
Anonymous user login				✓	✓
Import and export preferences				✓	✓
Send notifications to users				✓	✓
Custom license error messages				✓	✓
Run in COMSOL Client for automatically logged-in users					✓
Live search in the Application Library page					✓
Send notifications to users as email					✓

ELECTROMAGNETICS	4.X	5.0–1	5.2	5.3	5.4
Lumped ports and matrices for AC/DC	✓	✓	✓	✓	✓
Far fields in dielectric media	✓	✓	✓	✓	✓
S-parameter matrices for high-frequency electromagnetics	✓	✓	✓	✓	✓
Differential inductance	✓	✓	✓	✓	✓
Multiphysics interface electrostatic-structural interactions	✓	✓	✓	✓	✓
Coil excitation tools	✓	✓	✓	✓	✓
Porous media material models	✓	✓	✓	✓	✓
Electrical motors and generator tools	✓	✓	✓	✓	✓
Dispersive media	✓	✓	✓	✓	✓
Multiphysics interface for piezoresistivity	✓	✓	✓	✓	✓
S-parameter matrices for low-frequency electromagnetics	✓	✓	✓	✓	✓
Inductively coupled plasmas	✓	✓	✓	✓	✓
Periodic ports with Floquet periodicity	✓	✓	✓	✓	✓
Lumped RLC elements	✓	✓	✓	✓	✓
NEW Product: Wave Optics Module	✓	✓	✓	✓	✓
New E-J formulation for superconductive materials	✓	✓	✓	✓	✓
Vectorized floating potentials	✓	✓	✓	✓	✓
Electrical contact with surface roughness	✓	✓	✓	✓	✓
NEW Product: Semiconductor Module	✓	✓	✓	✓	✓
Nonlinear magnetic material library with 165 materials	✓	✓	✓	✓	✓
Improved multiphysics interface for induction heating	✓	✓	✓	✓	✓
Interior ports	✓	✓	✓	✓	✓
Transition boundary condition for thin conductive films	✓	✓	✓	✓	✓
Deposited microwave power boundary condition	✓	✓	✓	✓	✓
Gaussian background field	✓	✓	✓	✓	✓
Improved multiphysics interface for microwave heating	✓	✓	✓	✓	✓
Multiphysics interface for laser heating	✓	✓	✓	✓	✓
Improved multiphysics interface for Joule heating	✓	✓	✓	✓	✓
Thermal diffusion of electrons in plasmas	✓	✓	✓	✓	✓
Heterojunctions, impact ionization, and field-dependent mobility	✓	✓	✓	✓	✓
Small-signal analysis and incomplete ionization for semiconductors	✓	✓	✓	✓	✓
Automated meshing for infinite elements and perfectly matched layers		✓	✓	✓	✓
Automatic mesh adaption based on material properties		✓	✓	✓	✓
Numeric TEM ports for transmission lines		✓	✓	✓	✓
Multiphysics interface for optoelectronics		✓	✓	✓	✓
Linearly polarized wave as background field		✓	✓	✓	✓
NEW Product: Ray Optics Module		✓	✓	✓	✓
Equilibrium discharges for plasmas		✓	✓	✓	✓

ELECTROMAGNETICS	4.X	5.0–1	5.2	5.3	5.4
Doping models for semiconductors		✓	✓	✓	✓
Automatic meshing for dopant concentration gradients		✓	✓	✓	✓
Spontaneous emission		✓	✓	✓	✓
Light absorption and stimulated emission		✓	✓	✓	✓
Tunnel currents		✓	✓	✓	✓
Modeling of traps		✓	✓	✓	✓
Band gap narrowing models		✓	✓	✓	✓
Transmission line calculator application		✓	✓	✓	✓
Coil geometry analysis tool		✓	✓	✓	✓
SPICE export		✓	✓	✓	✓
SPICE components: PNP BJT, p-channel MOSFET, Mutual inductance, Transformer		✓	✓	✓	✓
Loss tangent, loss angle, and dissipation factor		✓	✓	✓	✓
Surface roughness on lossy conductive surfaces		✓	✓	✓	✓
Time-domain modeling of dispersive Drude-Lorentz media		✓	✓	✓	✓
Wavelength-domain study		✓	✓	✓	✓
Hexagonal periodic structures		✓	✓	✓	✓
Beam envelope method for ring resonators		✓	✓	✓	✓
Optical materials database with over 1400 materials		✓	✓	✓	✓
Optical components Part Library		✓	✓	✓	✓
Polarization ellipses plot		✓	✓	✓	✓
Multiphysics interface for ray heating		✓	✓	✓	✓
Ray release based on text file		✓	✓	✓	✓
Ray intensity computation in graded media			✓	✓	✓
Material models from externally programmed libraries written in C			✓	✓	✓
Effective nonlinear magnetic curves calculator			✓	✓	✓
Smith plots			✓	✓	✓
Optical fiber simulation application			✓	✓	✓
Multiphysics interface for thermoelastic damping in MEMS			✓	✓	✓
Vector hysteresis with the Jiles-Atherton material model			✓	✓	✓
Magnetic shielding with saturation effects			✓	✓	✓
Boundary surface current coils			✓	✓	✓
Domain terminal boundary condition for electrostatics and electric currents			✓	✓	✓
Mutual capacitance matrix export			✓	✓	✓
Improved asymptotic waveform evaluation and frequency-domain modal methods			✓	✓	✓
Two-port networks			✓	✓	✓
Polarization domain for nonlinear frequency mixing			✓	✓	✓
Optical ray propagation outside CAD geometry			✓	✓	✓

ELECTROMAGNETICS	4.X	5.0–1	5.2	5.3	5.4
Optical aberration plots			✓	✓	✓
Electrostatics based on the boundary element method (BEM)				✓	✓
Hybrid boundary-element--finite-element method (BEM-FEM) for electrostatics				✓	✓
Accelerated computation of capacitance matrix and other lumped matrices				✓	✓
Part library with waveguides, surface-mount footprints, and SMA connectors				✓	✓
Composite lumped LC and RLC elements				✓	✓
Touchstone file import for two-port network boundary condition				✓	✓
Surface magnetic current density boundary condition				✓	✓
Transient S-parameters for time-domain analysis				✓	✓
New postprocessing variables for effective isotropic radiated power and gains				✓	✓
Ray termination based on bounding box, intensity, or power				✓	✓
Photometric data file import for ray optics				✓	✓
Part variants for optical components				✓	✓
Emission according to Lambert's cosine law				✓	✓
Ray detector feature for selecting a subset of rays				✓	✓
Global modeling for initial analyses of plasma processes				✓	✓
Local field approximation for mean electron energy in plasmas				✓	✓
Automatic calculation of electron mobility for plasma simulations				✓	✓
Schrödinger equation interfaces				✓	✓
Current-driven metal contacts for semiconductor device simulations				✓	✓
Revolutionary new method for capacitively coupled plasma (CCP) simulations				✓	✓
Computation of ion energy distribution function (IEDF) and ion angular energy distribution function (IAEDF)				✓	✓
Hybrid boundary-element–finite-element method (BEM-FEM) for magnetostatics				✓	✓
Soft magnet material model for permanent magnets				✓	✓
Adaptive frequency sweep for high-frequency electromagnetics				✓	✓
Updated Electromagnetic Heating multiphysics coupling				✓	✓
Library of more than 60 RF and microwave substrate materials from Rogers Corporation				✓	✓
Generalized rotating machinery interface for magnetics				✓	✓
Edge launch connectors added to the RF Part Library				✓	✓
Deembedded ports				✓	✓
Physics-controlled mesh for frequency-dependent materials				✓	✓
Gaussian beam background field based on plane-wave expansion				✓	✓
Grid-based release of optical rays with cylindrical and hexapolar coordinates				✓	✓
Suppression of reflected rays during refraction				✓	✓
Termination based on the number of reflections				✓	✓
New parts for ray optics: Spherical General Lens, Circular Planar Annulus, On Axis Conic Mirror, Off Axis Conic Mirror				✓	✓
Semiconductor equilibrium study				✓	✓
Quasi-fermi-level formulation for semiconductor device simulations				✓	✓

ELECTROMAGNETICS	4.X	5.0–1	5.2	5.3	5.4
Power-driven terminal condition for semiconductor device simulations				✓	✓
Perfectly matched layers for Schrödinger equation analysis				✓	✓
Electric currents in layered shells					✓
Part Library for coils and magnetic cores					✓
Force computations for nonlinear materials using virtual work					✓
Uniform antenna array factor function					✓
Library of more than 100 RF and microwave substrate materials					✓
3D RCS calculations from 2D axisymmetric models					✓
Electrically thick layer boundary condition for interior boundaries					✓
Time-domain bandpass impulse response via FFT					✓
Far-field analysis for transient models					✓
Circularly polarized background field for 2D axisymmetry					✓
In- and outport direction arrows					✓
Numeric TEM ports with voltage drop direction					✓
One-way coupled multiphysics options in the Model Wizard					✓
Transition and impedance boundary condition for the beam envelope method interfaces					✓
Ports on interior boundaries for the beam envelope method interfaces					✓
Fully anisotropic refractive index tensor					✓
High-definition Part Library for ray optics					✓
Optical dispersion models for ray optics					✓
New algorithm for computing ray intensity and power					✓
Wavelength distributions at ray releases for polychromatic light					✓
Global modeling of non-Maxwellian discharges					✓
New Boltzmann Equation, Two-Term Approximation interface					✓
Pulsed electrical excitation for capacitively coupled plasmas					✓
Species Group feature for the Plasma, Time Periodic interface					✓
Multiphysics interface for the Schrödinger-Poisson Equation					✓
Trap-assisted surface recombination boundary condition					✓
WKB tunneling model					✓

HEAT TRANSFER	4.X	5.0–1	5.2	5.3	5.4
Multilayered shells	✓	✓	✓	✓	✓
Fans and grilles	✓	✓	✓	✓	✓
External radiation sources	✓	✓	✓	✓	✓
Solar irradiation	✓	✓	✓	✓	✓
Total power heat sources	✓	✓	✓	✓	✓
Moist air and condensation	✓	✓	✓	✓	✓
Load cases	✓	✓	✓	✓	✓

HEAT TRANSFER	4.X	5.0–1	5.2	5.3	5.4
Multiwavelength radiation	✓	✓	✓	✓	✓
Phase change with apparent heat capacity method	✓	✓	✓	✓	✓
Thermal contact with surface roughness	✓	✓	✓	✓	✓
Fast methods for radiation in participating media	✓	✓	✓	✓	✓
Multiphysics interface for thermoelectric effect	✓	✓	✓	✓	✓
Bioheating damage integral analysis	✓	✓	✓	✓	✓
Easy verification of global heat and energy balances	✓	✓	✓	✓	✓
Mixed low- and high-conductive multilayered shells		✓	✓	✓	✓
Heat transfer in fractures		✓	✓	✓	✓
Heat transfer in highly conductive rods		✓	✓	✓	✓
Cryogenic damage integral analysis		✓	✓	✓	✓
Fans and grilles for turbulent flow		✓	✓	✓	✓
Viscous dissipation		✓	✓	✓	✓
Isothermal domains		✓	✓	✓	✓
List of solar positions for cities		✓	✓	✓	✓
Multiphysics interface for nonisothermal flow		✓	✓	✓	✓
Algebraic turbulence models		✓	✓	✓	✓
Multiphysics interface for local thermal nonequilibrium		✓	✓	✓	✓
Coupled porous media and turbulent flow		✓	✓	✓	✓
Nonisothermal flow in porous media		✓	✓	✓	✓
Deposited beam power tool		✓	✓	✓	✓
Multiphysics interface for the Marangoni effect		✓	✓	✓	✓
Blackbody intensity and emissive power functions		✓	✓	✓	✓
5 times faster bioheating		✓	✓	✓	✓
Symmetry plane for surface-to-surface radiation			✓	✓	✓
Meteorological database for ambient conditions			✓	✓	✓
Multiphysics interface for heat and moisture transport			✓	✓	✓
Buoyancy effects in conjugate heat transfer			✓	✓	✓
Heat transfer in building materials			✓	✓	✓
Sector symmetry for heat radiation			✓	✓	✓
Updated bioheat material database			✓	✓	✓
Heat transfer in the frequency domain				✓	✓
Geometry parts for heat sinks				✓	✓
Library of building and refrigerant materials				✓	✓
Irreversible transformations in solids				✓	✓
Serendipity elements for heat transfer				✓	✓
Surface-to-surface radiation symmetry for perpendicular planes				✓	✓
Mixed diffuse and direct solar radiation				✓	✓

HEAT TRANSFER	4.X	5.0–1	5.2	5.3	5.4
New Moisture Flow multiphysics coupling interface				✓	✓
Moisture transfer coefficients				✓	✓
New inflow boundary condition based on known upstream conditions				✓	✓
Beer-Lambert law for absorption of light in weakly absorbing media				✓	✓
Thermally induced irreversible transformations in solids				✓	✓
Thermal contact by an equivalent thin resistive layer				✓	✓
Heat transfer coefficients library for arbitrary fluids				✓	✓
Meteorological database expanded to 8000 weather stations				✓	✓
Heat transfer in shape memory alloys (SMA)				✓	✓
Updated Electromagnetic Heating multiphysics coupling				✓	✓
Updated Thermoelectric Effect multiphysics coupling				✓	✓
Mixed diffuse-specular reflections and semitransparent surfaces					✓
Heat transfer in thin, layered structures					✓
Scattering control for radiation in participating media					✓
Arbitrary number of spectral bands for surface-to-surface radiation					✓
Light-diffusion equation interface					✓
Multiphysics couplings for heat transfer with radiation					✓
Multiphysics interfaces for heat and moisture flow					✓
New Heat Transfer in Solids and Fluids interface					✓
Thermal insulation for interior boundaries					✓
Ambient Thermal Properties tool					✓
Dedicated plots for temperature discontinuities					✓
Multiphysics interface for thermoelectric effects in composite materials					✓

STRUCTURAL MECHANICS	4.X	5.0–1	5.2	5.3	5.4
PMLs for piezoelectric materials	✓	✓	✓	✓	✓
Infinite elements for solid mechanics	✓	✓	✓	✓	✓
Prestressed analysis	✓	✓	✓	✓	✓
NEW Product: Geomechanics Module	✓	✓	✓	✓	✓
Voigt notation for anisotropic materials	✓	✓	✓	✓	✓
Specify elastic materials using 9 different property combinations	✓	✓	✓	✓	✓
Thin-film damping for MEMS	✓	✓	✓	✓	✓
New contact solver based on double dogleg method	✓	✓	✓	✓	✓
Load cases	✓	✓	✓	✓	✓
Membranes	✓	✓	✓	✓	✓
Cyclic and Floquet periodicity	✓	✓	✓	✓	✓
Rigid connectors	✓	✓	✓	✓	✓
Low-reflecting boundary conditions for transient elastic waves	✓	✓	✓	✓	✓

STRUCTURAL MECHANICS	4.X	5.0–1	5.2	5.3	5.4
Buckling for trusses	✓	✓	✓	✓	✓
NEW Product: Nonlinear Structural Materials Module	✓	✓	✓	✓	✓
Yeoh, Varga, and Blatz-Ko hyperelasticity	✓	✓	✓	✓	✓
Dilation angle for soil	✓	✓	✓	✓	✓
NEW Product: Fatigue Module	✓	✓	✓	✓	✓
Bolt pretension	✓	✓	✓	✓	✓
Beam cross-section user interface	✓	✓	✓	✓	✓
Gent, Gao, and Storakers hyperelasticity	✓	✓	✓	✓	✓
Rainflow fatigue analysis	✓	✓	✓	✓	✓
NEW Product: Multibody Dynamics Module	✓	✓	✓	✓	✓
Multiphysics interface for MEMS thermoelasticity	✓	✓	✓	✓	✓
Thermal expansion for piezomaterials	✓	✓	✓	✓	✓
Rotordynamic forces	✓	✓	✓	✓	✓
Contact penalty method	✓	✓	✓	✓	✓
Solid-shell and shell-beam connections	✓	✓	✓	✓	✓
Rigid domains	✓	✓	✓	✓	✓
Timoshenko beams	✓	✓	✓	✓	✓
New thermal stress multiphysics interface	✓	✓	✓	✓	✓
Fatigue in nonlinear materials and thermal fatigue	✓	✓	✓	✓	✓
Fixed joint, distance joint, universal joint, and friction in joints	✓	✓	✓	✓	✓
Improved multiphysics interface for thermal stress	✓	✓	✓	✓	✓
Geometrically nonlinear beams		✓	✓	✓	✓
Improved fluid-structure interaction for fixed and flexible geometry		✓	✓	✓	✓
Spring and damper matrices		✓	✓	✓	✓
Multiphysics interface for hygroscopic swelling		✓	✓	✓	✓
Easy couplings between shells and beams		✓	✓	✓	✓
Nonlinear elastic materials		✓	✓	✓	✓
Orthotropic, anisotropic, and hyperelastic membranes		✓	✓	✓	✓
Nonlinear elastic materials		✓	✓	✓	✓
Stress-life and strain-life fatigue models		✓	✓	✓	✓
Elastic joints and base motion for multibody dynamics		✓	✓	✓	✓
Multiphysics interfaces for multibody dynamics with heat transfer		✓	✓	✓	✓
Multiphysics interfaces for multibody dynamics with pressure acoustics		✓	✓	✓	✓
New multiphysics interface for the piezoelectric effect		✓	✓	✓	✓
Improved multiphysics interface for piezoelectric effect		✓	✓	✓	✓
Dielectric loss in piezoelectric materials		✓	✓	✓	✓
Built-in quartz material properties		✓	✓	✓	✓
Part Library for mechanical components		✓	✓	✓	✓

STRUCTURAL MECHANICS	4.X	5.0–1	5.2	5.3	5.4
External stress interface		✓	✓	✓	✓
Viscous damping		✓	✓	✓	✓
Nonlinear elasticity, viscoelasticity, creep, and viscoplasticity for membranes		✓	✓	✓	✓
Plasticity in trusses		✓	✓	✓	✓
Point trajectory plots for multibody dynamics		✓	✓	✓	✓
Perforations in thin-film flow for MEMS		✓	✓	✓	✓
Material models from externally programmed libraries written in C			✓	✓	✓
Optimized contact for small displacements			✓	✓	✓
Adhesion and decohesion for mechanical contact			✓	✓	✓
Multiphysics interface for magnetostriction			✓	✓	✓
New plasticity material models			✓	✓	✓
Multiphysics interface for piezoresistivity			✓	✓	✓
Serendipity elements			✓	✓	✓
Tangent coefficient of thermal expansion			✓	✓	✓
Thermal expansion of constraints			✓	✓	✓
Multiphysics interface for poroelasticity			✓	✓	✓
Periodic conditions for shells			✓	✓	✓
NEW Product: Rotordynamics Module			✓	✓	✓
Solid and beam rotor interfaces for rotordynamic applications			✓	✓	✓
Hydrodynamic bearings for rotordynamic applications			✓	✓	✓
Whirl, Waterfall, and Orbit plots for rotordynamics applications			✓	✓	✓
Large-strain viscoelasticity			✓	✓	✓
Mixed isotropic and kinematic hardening			✓	✓	✓
New isotropic and kinematic hardening material models for plasticity			✓	✓	✓
Subsurface fatigue with the Dang-Van material model			✓	✓	✓
Gear modeling for multibody dynamics			✓	✓	✓
Part Library with parameterized gears			✓	✓	✓
Stress linearization evaluation of membrane, bending, and peak stress				✓	✓
Study step and automatic symmetry detection for prestressed bolts				✓	✓
Automatic suppression of rigid body motion				✓	✓
Computation of safety factors for 12 safety criteria				✓	✓
Linear buckling analysis for beams				✓	✓
Dedicated data set for shell analysis				✓	✓
Material data for thin elastic layers and spring foundation				✓	✓
2D cross-sectional mode analysis for out-of-plane elastic waves				✓	✓
Multiplicative decomposition of inelastic strains				✓	✓
Rigid domain for shells and beams				✓	✓
Rigid connector for beams				✓	✓

STRUCTURAL MECHANICS	4.X	5.0–1	5.2	5.3	5.4
Spring boundary conditions for rigid domains and connectors				✓	✓
Complete set of energy variables for mechanical contact				✓	✓
Frequency-response of mechanical contact models				✓	✓
Extended functionality for external material models written in C				✓	✓
Perzyna and Chaboche viscoplastic material models				✓	✓
Material models for porous plasticity				✓	✓
Anisotropic thermal expansion and hygroscopic swelling for hyperelastic materials				✓	✓
Hardening of elliptic caps in soil plasticity analyses				✓	✓
Vibration fatigue analysis				✓	✓
Highlighting of joints for multibody dynamics analyses				✓	✓
Penalty method for computing joint forces				✓	✓
Attachments on rigid bodies				✓	✓
Inlets and outlets for hydrodynamic bearings				✓	✓
Rotor bearing system simulator application				✓	✓
Shape memory alloy (SMA) material models				✓	✓
Generalized multiphysics interface for fluid-structure interaction (FSI)				✓	✓
Bolt thread contact modeling				✓	✓
Solid-beam coupling in 3D models				✓	✓
Generalized plane strain formulation				✓	✓
Cam-follower joint condition for multibody dynamics				✓	✓
Lumped mechanical system interface				✓	✓
Ball and roller bearings for rotordynamics simulations				✓	✓
Improved default plots for several structural mechanics interfaces				✓	✓
C-profile and hat beam cross sections				✓	✓
Option to exclude the constraints on lower geometric entity levels				✓	✓
Eigenfrequency analysis following a mechanical contact analysis				✓	✓
Mechanical losses associated to thermal stress				✓	✓
Failure criteria for membranes and concrete				✓	✓
Plastic hardening and void nucleation in porous plasticity				✓	✓
New soil material models: Modified Cam-Clay, Hardening Soil, Extended Barcelona Basic, and Modified Structured Cam-Clay				✓	✓
Solid-bearing multiphysics coupling for hydrodynamic bearings				✓	✓
Hydrodynamic thrust bearings				✓	✓
NEW Product: Composite Materials Module					✓
New user interfaces for defining layered stacks and orientation for composite materials					✓
Layered material data sets and plots					✓
Composite material analysis based on layerwise and equivalent single layer theory					✓
Response spectrum analysis					✓
Representative volume elements (RVE) for homogenization of periodic materials					✓

STRUCTURAL MECHANICS	4.X	5.0–1	5.2	5.3	5.4
Shell interface for axisymmetric analysis					✓
Multiphysics interface for fluid-structure interaction with shells and membranes					✓
Multiphysics interface for fluid-structure interaction with composite materials					✓
Multiphysics interface for fluid-structure interaction with structural assemblies					✓
Multiphysics interface for fluid-structure interaction with multibody dynamics of rigid and flexible bodies					✓
Multiphysics interface for acoustic-structure interaction with composite materials					✓
Multiphysics interface for thermal expansion in composite materials					✓
Multiphysics interface for Joule heating in composite materials					✓
Multiphysics interface for thermoelectric effect in composite materials					✓
Activation of material for additive manufacturing					✓
Roller condition with analytical normal orientation					✓
Reaction-free symmetry boundary conditions					✓
New studies for modal superposition in the time and frequency domain					✓
Burgers viscoelastic model					✓
Rigid connectors for edges and points					✓
Flexible formulation for rigid connectors and attachments					✓
Utility function library for external materials					✓
Mullins effect for hyperelastic materials					✓
Continuum-based damage model for brittle materials					✓
New modeling options for hyperelastic materials with low compressibility					✓
Fatigue evaluation for membranes					✓
Mean stress correction for fatigue analysis based on the Goodman, Gerber, and Soderberg methods					✓
Rolling element bearings for multibody dynamics					✓
Body defining reference frame for results and visualizations					✓
Floating ring bearings					✓
Misalignment in bearings					✓
Rotor coupling					✓
Foundations for roller bearings					✓
Roller force distribution					✓
Multiphysics interface for electromechanics with structural FEM and electrostatics BEM					✓

ACOUSTICS	4.X	5.0–1	5.2	5.3	5.4
Multiphysics interface for acoustic-piezo interactions	✓	✓	✓	✓	✓
Multiphysics interface for acoustic-shell interactions	✓	✓	✓	✓	✓
Multiphysics interface for poroelastic waves	✓	✓	✓	✓	✓
Multiphysics interface for thermoviscous acoustics	✓	✓	✓	✓	✓
Multiphysics interface for thermoviscous acoustic-solid interactions	✓	✓	✓	✓	✓
Multiphysics interface for time-domain pipe acoustics	✓	✓	✓	✓	✓

ACOUSTICS	4.X	5.0–1	5.2	5.3	5.4
Multiphysics interface for membrane-acoustic interactions	✓	✓	✓	✓	✓
Multiphysics interface for thermoviscous acoustic-shell interactions	✓	✓	✓	✓	✓
Thermoviscous acoustic boundary condition approximation	✓	✓	✓	✓	✓
Multiphysics interface for frequency-domain pipe acoustics	✓	✓	✓	✓	✓
Aeroacoustics with linearized Euler equations	✓	✓	✓	✓	✓
Ray acoustics		✓	✓	✓	✓
Acoustic diffusion		✓	✓	✓	✓
New multiphysics interface for the piezoelectric effect		✓	✓	✓	✓
Aeroacoustics with linearized Navier-Stokes equations		✓	✓	✓	✓
Predefined impedance boundary conditions		✓	✓	✓	✓
Expanded poroacoustic fluid models		✓	✓	✓	✓
Dipole and quadrupole sources		✓	✓	✓	✓
Visualize far fields on grid outside computational mesh		✓	✓	✓	✓
Octave plots			✓	✓	✓
New multiphysics interface for poroelastic waves			✓	✓	✓
Discontinuous Galerkin method for ultrasound with background flow			✓	✓	✓
Directivity plot			✓	✓	✓
Background acoustic fields for thermoviscous acoustics			✓	✓	✓
Background acoustic fields for linearized Navier-Stokes and Euler aeroacoustics			✓	✓	✓
Ray power and sound pressure level for ray acoustics			✓	✓	✓
Acoustic ray propagation outside CAD geometry			✓	✓	✓
Cylindrical and spherical waves for background fields in pressure acoustics			✓	✓	✓
Electroacoustic couplings for loudspeakers			✓	✓	✓
Logarithmic and ISO preferred frequency sweeps			✓	✓	✓
Perfectly matched layers (PMLs) for pressure acoustics in the time domain				✓	✓
Thermoviscous acoustics in the time domain				✓	✓
Serendipity elements for acoustics				✓	✓
New numerical stabilization for linearized Navier-Stokes analyses				✓	✓
2D axisymmetric convected wave equation based on the discontinuous Galerkin method				✓	✓
Thermal and viscous losses in poroelastic waves based on the Biot-Allard model				✓	✓
Interior Perforated plate condition				✓	✓
Beam width calculations for far-field plots				✓	✓
Hybrid BEM-FEM for acoustics, acoustic-structure, and acoustics-piezo interactions				✓	✓
Impulse response analysis for ray acoustics				✓	✓
Discontinuous Galerkin explicit method for time-dependent acoustics				✓	✓
Absorbing layers for linearized Euler aeroacoustics in the time domain				✓	✓
Plane wave expansion for pressure acoustics in 2D axisymmetric models				✓	✓
Incident monochromatic plane waves for transient acoustics				✓	✓

ACOUSTICS	4.X	5.0–1	5.2	5.3	5.4
Linear and logarithmic frequency axis option for directivity plots				✓	✓
Improved solver suggestions for multiphysics couplings and transient analysis				✓	✓
Port boundary conditions for pressure acoustics					✓
Nonlinear acoustics Westervelt model for high sound pressure levels					✓
Atmosphere and ocean attenuation material models					✓
Exterior field calculation for evaluations outside the computational domain					✓
Multiphysics BEM-FEM coupling to thermoviscous acoustics					✓
Multiphysics BEM-FEM coupling to poroelastic waves					✓
Interior velocity and interior displacement boundary conditions for BEM					✓
Impedance condition, including RCL circuit and physiological, for BEM					✓
Adiabatic formulation for linearized Navier-Stokes and thermoviscous acoustics					✓
Gradient term suppression stabilization for linearized Navier-Stokes					✓
Modulated Gaussian pulse option for background and incident fields					✓
More advanced properties for the built-in materials for air and water					✓
Improved method for calculating intensity in absorbing and attenuating media					✓

FLUID FLOW	4.X	5.0–1	5.2	5.3	5.4
High Mach number flow	✓	✓	✓	✓	✓
NEW Product: Microfluidics Module	✓	✓	✓	✓	✓
k-omega turbulence model	✓	✓	✓	✓	✓
Euler-Euler two-phase flow	✓	✓	✓	✓	✓
Slip flow	✓	✓	✓	✓	✓
Turbulent mixing	✓	✓	✓	✓	✓
NEW Product: Pipe Flow Module	✓	✓	✓	✓	✓
Automatic boundary layer meshing	✓	✓	✓	✓	✓
Turbulent reacting flow	✓	✓	✓	✓	✓
SCCM inflow	✓	✓	✓	✓	✓
Frozen rotor method	✓	✓	✓	✓	✓
SST turbulence	✓	✓	✓	✓	✓
Thin screens	✓	✓	✓	✓	✓
Heat transfer with phase change	✓	✓	✓	✓	✓
Two-phase flow in pipes	✓	✓	✓	✓	✓
Multiphysics interface for frequency-domain pipe acoustics	✓	✓	✓	✓	✓
NEW Product: Molecular Flow Module	✓	✓	✓	✓	✓
Wall surface roughness for turbulent flow	✓	✓	✓	✓	✓
Anisotropic porous media flow with Brinkman equations	✓	✓	✓	✓	✓
NEW Product: Mixer Module	✓	✓	✓	✓	✓
Algebraic turbulence models		✓	✓	✓	✓

FLUID FLOW	4.X	5.0–1	5.2	5.3	5.4
Turbulence with grilles and fans		✓	✓	✓	✓
New multiphysics interface for nonisothermal flow		✓	✓	✓	✓
SST turbulence model for reacting flow		✓	✓	✓	✓
Cavitation for thin-film flow		✓	✓	✓	✓
Rotating machinery with multiphase flow		✓	✓	✓	✓
Multiphysics interface for transport of diluted species in porous media		✓	✓	✓	✓
Partially saturated porous media		✓	✓	✓	✓
3D laminar flow to 1D pipe flow connection		✓	✓	✓	✓
Euler-Euler two-phase flow for turbulent flow		✓	✓	✓	✓
Coupled porous media and turbulent flow		✓	✓	✓	✓
Capillary pressure in two-phase porous media flow		✓	✓	✓	✓
Perforations for thin-film flow		✓	✓	✓	✓
Infinite elements for porous media		✓	✓	✓	✓
Part Library with mixer equipment components		✓	✓	✓	✓
Part Library with microfluidic channels		✓	✓	✓	✓
New y-junctions and n-way junctions for pipe flow		✓	✓	✓	✓
Parallelized molecular flow computations		✓	✓	✓	✓
Molecular flow with multiple species		✓	✓	✓	✓
Three-phase laminar flow			✓	✓	✓
Algebraic turbulence for rotating machinery			✓	✓	✓
Stationary free surface flow computation			✓	✓	✓
Algebraic turbulence for mixing			✓	✓	✓
Compressible flow in 1D pipes			✓	✓	✓
Easy definition of gravity and buoyancy effects			✓	✓	✓
Built-in Boussinesq approximation for nonisothermal flow			✓	✓	✓
Swirl flow for Fan boundary condition			✓	✓	✓
Temperature changes from pressure work in porous media flow			✓	✓	✓
Multiphysics interface for reacting flow			✓	✓	✓
Graphics icons for pipe system components			✓	✓	✓
Pump inlet condition and pump curve data for pipe flow			✓	✓	✓
Flownet plots for subsurface flow			✓	✓	✓
v2-f turbulence model				✓	✓
Automatic wall treatment for turbulent flow				✓	✓
Automatic translation between turbulence models				✓	✓
Algebraic multigrid (AMG) solver for CFD				✓	✓
New formulation for high Mach number flow				✓	✓
New interior wall and thin barrier boundary conditions for porous media flow				✓	✓
New well boundary condition for subsurface flow in porous media				✓	✓
Reacting flow in porous media				✓	✓

FLUID FLOW	4.X	5.0–1	5.2	5.3	5.4
Transport of diluted species in porous media and fractures				✓	✓
Plane symmetry condition for free molecular flow				✓	✓
Generalized multiphysics interface for fluid-structure interaction (FSI)				✓	✓
Inlet boundary conditions for fully developed turbulent flow				✓	✓
Realizable k-ε turbulence model				✓	✓
Buoyancy-induced turbulence				✓	✓
All turbulence models made available for multiphase flow				✓	✓
Rotating machinery interfaces made available for all flow interfaces				✓	✓
Updated free and porous media flow interface				✓	✓
Kozeny-Carman permeability model for Darcy's law				✓	✓
Thin barrier feature in the two-phase Darcy's law interface				✓	✓
Cubic law for fracture transmissivity in fracture flow				✓	✓
Large eddy simulation (LES) for single-phase flow					✓
Phase transport in free and porous media					✓
Fully developed flow at inlets and outlets for turbulent flow					✓
Non-Newtonian yield-stress fluids: Bingham-Papanastasiou, Casson-Papanastasiou models, Herschel-Bulkley-Papanastasiou					✓
Two-phase flow with level set and phase field for all turbulence models					✓
Interior wetted wall for two-phase flow					✓
Pipe connection for combining 1D pipe flow with 3D single-phase flow					✓

CHEMICAL	4.X	5.0–1	5.2	5.3	5.4
Surface reactions	✓	✓	✓	✓	✓
Infinite elements for diffusion	✓	✓	✓	✓	✓
Parameter estimation with the Optimization Module	✓	✓	✓	✓	✓
Reacting flow	✓	✓	✓	✓	✓
AC impedance spectroscopy	✓	✓	✓	✓	✓
NEW Product: Electrodeposition Module	✓	✓	✓	✓	✓
Infinite elements for electrochemical currents	✓	✓	✓	✓	✓
Shell electrodes	✓	✓	✓	✓	✓
Potentiostatic control	✓	✓	✓	✓	✓
NEW Product: Corrosion Module	✓	✓	✓	✓	✓
Film resistance	✓	✓	✓	✓	✓
Thin impermeable barrier	✓	✓	✓	✓	✓
Edge electrodes	✓	✓	✓	✓	✓
Infinite electrolytes	✓	✓	✓	✓	✓
NEW Product: Electrochemistry Module	✓	✓	✓	✓	✓
Multicomponent flash calculations	✓	✓	✓	✓	✓
Multiscale simulations for packed bed reactors		✓	✓	✓	✓

CHEMICAL	4.X	5.0–1	5.2	5.3	5.4
New Chemistry interface		✓	✓	✓	✓
Multiphysics interface for transport of diluted species in porous media		✓	✓	✓	✓
Mass-based concentrations		✓	✓	✓	✓
Partially saturated porous media		✓	✓	✓	✓
Equilibrium reactions		✓	✓	✓	✓
Current distribution on edges with the boundary element method (BEM)		✓	✓	✓	✓
Counter electrodes for electroanalysis		✓	✓	✓	✓
New gas mixture viscosity correlation for reaction engineering		✓	✓	✓	✓
Film resistance for reactive pellets		✓	✓	✓	✓
Multiphysics interface for hygroscopic swelling with species transport		✓	✓	✓	✓
Dusty gas model		✓	✓	✓	✓
Mass-based concentration variables		✓	✓	✓	✓
Nonspherical catalytic pellet shapes			✓	✓	✓
Volumetric effects from edge elements			✓	✓	✓
Thin insulating sheets for corrosion simulations			✓	✓	✓
Multicomponent transport in porous media flow			✓	✓	✓
Surface reactions for reactive pellet beds			✓	✓	✓
Export surface reaction kinetics to space-dependent model			✓	✓	✓
Single particle battery interface for simplified modeling of batteries			✓	✓	✓
Nernst-Planck-Poisson equations interface			✓	✓	✓
Short-circuit boundary condition for batteries and corrosion			✓	✓	✓
Multiphysics interface for electrochemical heat source			✓	✓	✓
Thermodynamic equilibrium electrode kinetics			✓	✓	✓
Electrophoretic transport interface				✓	✓
Ion-exchange membrane internal boundary condition for tertiary currents				✓	✓
Four charge conservation models for tertiary currents with Nernst-Planck equations				✓	✓
Thin electrode layers in electrode domains				✓	✓
Thin electrolyte layers between electrolyte domains				✓	✓
Charge-discharge cycling boundary condition				✓	✓
Circuit terminal for couplings to electrical circuits				✓	✓
Primary and secondary current distribution based on the boundary element method (BEM)				✓	✓
Shell current distribution analysis for thin electrolytes				✓	✓
A built-in thermodynamic properties library for pure fluids, mixtures, and two-phase fluids				✓	✓
Link between Reaction Engineering and Chemistry interfaces and thermodynamic property packages				✓	✓
Electrode reactions on thin electrode surfaces fully immersed in electrolyte				✓	✓
New Lithium-Ion Battery Designer application for optimizing batteries for specific use cases				✓	✓

CHEMICAL	4.X	5.0–1	5.2	5.3	5.4
Baker-Verbrugge diffusion model, in the Lithium-Ion Battery and Battery with Binary Electrolyte interfaces					✓
Updated Thermodynamics interface					✓
Partition condition for prescribing the ratio between concentrations in two adjacent phases					✓
Infinitely fast irreversible heterogeneous reactions					✓
Bulk and surface equilibrium reactions for concentrated species					✓
Automatic definition of equilibrium constants based on thermodynamics properties					✓
Lumped battery interface					✓
Stress and strain in electrode particles due to lithium intercalation					✓
Equivalent circuit modeling of batteries					✓
Multiple ion transport for ion-exchange membranes					✓
Level set interface for corrosion modeling					✓

OPTIMIZATION	4.X	5.0–1	5.2	5.3	5.4
Time-dependent sensitivity and optimization	✓	✓	✓	✓	✓
Parameter optimization	✓	✓	✓	✓	✓
Design optimization	✓	✓	✓	✓	✓
Gradient-based and derivative-free optimization study	✓	✓	✓	✓	✓
New derivative-free optimization solver: BOBYQA	✓	✓	✓	✓	✓
New gradient-based optimization solver: MMA	✓	✓	✓	✓	✓
Multianalysis optimization		✓	✓	✓	✓
New parameter estimation study		✓	✓	✓	✓
Optimization solver stop and continue		✓	✓	✓	✓
New derivative-free method: COBYLA		✓	✓	✓	✓
New least square fitting method			✓	✓	✓
Density model feature for topology optimization					✓
Combined parametric sweeps with derivative-free optimization					✓

MATERIAL LIBRARY PRODUCT	4.X	5.0–1	5.2	5.3	5.4
2500 materials	✓	✓	✓	✓	✓
More than 150 new materials				✓	✓

PARTICLE TRACING	4.X	5.0–1	5.2	5.3	5.4
NEW Product: Particle Tracing	✓	✓	✓	✓	✓
Particle forces: electric, magnetic, collisional, drag, gravity, acoustophoretic, dielectrophoretic, and user defined	✓	✓	✓	✓	✓
New forces: Brownian, Schiller-Naumann, magnetophoretic, and thermophoretic	✓	✓	✓	✓	✓
Secondary emission	✓	✓	✓	✓	✓
Particle-particle interactions	✓	✓	✓	✓	✓
Diffuse and general reflection	✓	✓	✓	✓	✓
Velocity reinitialization	✓	✓	✓	✓	✓
Monte Carlo elastic collisions	✓	✓	✓	✓	✓
Changing auxiliary variables	✓	✓	✓	✓	✓
Particle-field and fluid-particle interactions	✓	✓	✓	✓	✓
Release of particles in a cone	✓	✓	✓	✓	✓
Max, min, and average over particles	✓	✓	✓	✓	✓
New accumulator tools enabling multiphysics couplings for erosion, etching, mass deposition, boundary load, mass flux, current density, and heat source		✓	✓	✓	✓
Particle 1D plots		✓	✓	✓	✓
Multiphysics interface for electric-particle field interaction		✓	✓	✓	✓
Multiphysics interface for magnetic-particle field interaction		✓	✓	✓	✓
New multiphysics interface for fluid-particle interaction		✓	✓	✓	✓
Inelastic collisions		✓	✓	✓	✓
Particle beams with beam emittance and Twiss parameters		✓	✓	✓	✓
Space-charge limited emission		✓	✓	✓	✓
Charge-exchange collisions			✓	✓	✓
Release from edges and points			✓	✓	✓
Improved density-based release			✓	✓	✓
Particle counters			✓	✓	✓
Particle-matter interactions			✓	✓	✓
High-order Runge-Kutta time-stepping method for first-order Newtonian formulation			✓	✓	✓
Store extra time steps for wall interactions			✓	✓	✓
Improved particle beam simulations with sampling from phase space ellipse			✓	✓	✓
Turbulent dispersion models for particles			✓	✓	✓
Liquid droplet breakup with the Kelvin-Helmholtz and Rayleigh-Taylor breakup models			✓	✓	✓
Periodic boundary condition for particle tracing				✓	✓
Rotating frames for particle tracing				✓	✓
Release particles at random initial positions				✓	✓
Ribbons on particle trajectories				✓	✓
Coordinate system selection for inlets				✓	✓
Lambertian velocity distribution for particle release at boundaries				✓	✓
Nonuniform magnitudes in velocity distributions				✓	✓

PARTICLE TRACING	4.X	5.0–1	5.2	5.3	5.4
Lift force for particle tracing in fluids				✓	✓
Anisotropic turbulent dispersion for particles in fluids				✓	✓
Thermionic emission of electrons at hot metal cathodes				✓	✓
Drag correction factor for particles close to walls				✓	✓
Symmetry boundary condition for particle tracing				✓	✓
New component couplings on particles				✓	✓
Null collision method for charged particle tracing in rarified gas				✓	✓
Uniform, normal, or lognormal distribution of particle release times				✓	✓
Recycling of particle degrees of freedom for use in secondary emission				✓	✓
General time periodic electric and magnetic forces				✓	✓
Release particles based on the thermal distribution on a wall				✓	✓
Release particles from a cylindrical or hexapolar grid of points				✓	✓
Accumulators for velocity reinitialization to compute, for example, spatial density of collisions					✓
Offset velocity distributions of released particles					✓

INTERFACING	4.X	5.0–1	5.2	5.3	5.4
NEW Product: LiveLink™ *for* AutoCAD®	✓	✓	✓	✓	✓
NEW Product: LiveLink™ *for* PTC® Creo® Parametric™	✓	✓	✓	✓	✓
NEW Product: LiveLink™ *for* Excel®	✓	✓	✓	✓	✓
NEW Product: ECAD Import Module	✓	✓	✓	✓	✓
NEW Product: LiveLink™ *for* Solid Edge®	✓	✓	✓	✓	✓
NEW Product: LiveLink™ *for* Revit®	✓	✓	✓	✓	✓
NEW Product: Design Module	✓	✓	✓	✓	✓

NEW CAD FILE FORMATS	4.X	5.0–1	5.2	5.3	5.4
PTC® Creo® Parametric™ 1.0 software	✓	✓	✓	✓	✓
ACIS® (SAT®) R22 software	✓	✓	✓	✓	✓
CATIA® V5 R21 software	✓	✓	✓	✓	✓
Autodesk® Inventor® 2012 software	✓	✓	✓	✓	✓
Parasolid® R23, R24 software	✓	✓	✓	✓	✓
SOLIDWORKS® 2012 software	✓	✓	✓	✓	✓
Catia® V5 R 22 software	✓	✓	✓	✓	✓
Parasolid® V 25 software	✓	✓	✓	✓	✓
SOLIDWORKS® 2013 software	✓	✓	✓	✓	✓
Autodesk® Inventor® 2013 software	✓	✓	✓	✓	✓
PTC® Creo® Parametric™ 2.0 software	✓	✓	✓	✓	✓
NX™ (.prt) software		✓	✓	✓	✓
Autodesk® AutoCAD® (.dwg, .dxf) software		✓	✓	✓	✓

NEW CAD FILE FORMATS	4.X	5.0–1	5.2	5.3	5.4
SOLIDWORKS® 2014 software		✓	✓	✓	✓
Autodesk® Inventor® 2015 software		✓	✓	✓	✓
Parasolid® V 28.1 software			✓	✓	✓
ACIS® (SAT®) R25, 2016 1.0 software			✓	✓	✓
CATIA® V5 R8-R25, 2016			✓	✓	✓
Inventor® parts and assemblies versions 11, 2008-2016			✓	✓	✓
SOLIDWORKS® versions 98-2016			✓	✓	✓
AutoCAD® versions 2.5-2016			✓	✓	✓
AutoCAD® DXF™ versions 2.5-2016			✓	✓	✓
Parasolid® V 29.1 software				✓	✓
ACIS® (SAT®) R25, 2017 1.0 software				✓	✓
Inventor® parts and assemblies version 11, 2017				✓	✓
SOLIDWORKS® 2017 software				✓	✓
NX™ (.prt) software version 11				✓	✓
Parasolid® V 30.0 software				✓	✓
ACIS® (SAT®) R25, 2018 1.0 software				✓	✓
AutoCAD® (.dwg, .dxf) up to 2017				✓	✓
CATIA® V5 up to 2017				✓	✓
PTC® Creo® Parametric™ up to 4.0				✓	✓
AutoCAD® (.dwg, .dxf) versions 2018-2019					✓
Inventor® (.iam, .ipt) versions 2018-2019					✓
NX™ (.prt) software version 12					✓
Parasolid® (.x_t, .xmt_txt, .x_b, .xmt_bin): V31.0					✓
PTC® Creo® Parametric™ (.prt, .asm): 5.0					✓
SOLIDWORKS® (.sldprt, .sldasm): 2018					✓

LIVELINK™ *for* SOLIDWORKS®	4.X	5.0–1	5.2	5.3	5.4
One-window interface	✓	✓	✓	✓	✓
Parameter linking	✓	✓	✓	✓	✓
Sync material names	✓	✓	✓	✓	✓
Sync user-defined selections	✓	✓	✓	✓	✓
Run applications using LiveLink™ *for* SOLIDWORKS®		✓	✓	✓	✓
Connecting to COMSOL Server™ from within the SOLIDWORKS® interface			✓	✓	✓
Tracking of document information including file name and file path			✓	✓	✓
More efficient setup of CAD assembly selections				✓	✓
Synchronizing read-only parameters					✓
Object selections from material selections					✓
Assembly-level pattern features in selections					✓

LiveLink™ *for* INVENTOR®	4.X	5.0–1	5.2	5.3	5.4
Parameter linking	✓	✓	✓	✓	✓
One-window interface	✓	✓	✓	✓	✓
Sync material names and selections	✓	✓	✓	✓	✓
Connecting to COMSOL Server™ from within the Autodesk® Inventor® interface			✓	✓	✓
Tracking of document information including file name and file path			✓	✓	✓
More efficient setup of CAD assembly selections				✓	✓
Synchronizing read-only parameters					✓
Object selections from material selections					✓

LiveLink™ *for* AUTOCAD®	4.X	5.0–1	5.2	5.3	5.4
Connecting to COMSOL Server™ from within the AutoCAD® interface				✓	✓
Synchronize selections for materials				✓	✓
Tracking of document information including file name and file path				✓	✓
Synchronize curves and points				✓	✓
Synchronizing read-only parameters					✓
Object selections from material selections					✓

LiveLink™ *for* PTC® PRO/ENGINEER®	4.X	5.0–1	5.2	5.3	5.4
Synchronize selections for materials			✓	✓	✓
Tracking of document information including file name and file path			✓	✓	✓
Synchronizing read-only parameters					✓
Object selections from material selections					✓

LiveLink™ *for* PTC® CREO® PARAMETRIC™	4.X	5.0–1	5.2	5.3	5.4
Synchronize selections for materials			✓	✓	✓
Connecting to COMSOL Server™ from within the PTC® Creo® Parametric™ interface			✓	✓	✓
Tracking of document information including file name and file path			✓	✓	✓
Parameter selection in CAD assembly components				✓	✓
Synchronizing read-only parameters					✓
Object selections from material selections					✓
User-defined selections					✓

LiveLink™ *for* SOLID EDGE®	4.X	5.0–1	5.2	5.3	5.4
Synchronize selections for materials			✓	✓	✓
Connecting to COMSOL Server™ from within the Solid Edge® interface			✓	✓	✓
Tracking of document information including file name and file path			✓	✓	✓
Synchronizing read-only parameters					✓
Object selections from material selections					✓

LIVELINK™ *for* REVIT®	4.X	5.0–1	5.2	5.3	5.4
Connecting to COMSOL Server™ from within the Autodesk® Revit® interface				✓	✓
Tracking of document information including file name and file path				✓	✓
Expanded support for synchronizing architectural elements				✓	✓
Synchronizing read-only parameters					✓

ECAD IMPORT MODULE	4.X	5.0–1	5.2	5.3	5.4
ODB++ import	✓	✓	✓	✓	✓
Layer renaming		✓	✓	✓	✓
Selections for layers			✓	✓	✓
Split layers in imported GDS files based on data type				✓	✓
Support for the IPC-2581 PCB layout format				✓	✓
Net selections for ODB++ and IPC-2581 files					✓
Select all metal and dielectric layers option					✓
Clear all imports option					✓

LIVELINK™ *for* MATLAB®	4.X	5.0–1	5.2	5.3	5.4
Improved performance and memory handling	✓	✓	✓	✓	✓
Model navigator	✓	✓	✓	✓	✓
New functions*	✓	✓	✓	✓	✓
Updates to mphnavigator , mpheval, mphint, mphinterp , mphplot, mphsolutioninfo, and mphtable	✓	✓	✓	✓	✓
New client/server functionality		✓	✓	✓	✓
Updates to mphplot		✓	✓	✓	✓
New functions: mphevaluate, mphinterpolationfile, mphwritestl, mphreadstl, and mphsurf		✓	✓	✓	✓
Updates to mphxmeshinfo, mphmean, mphmax, mphmin, and mphint2		✓	✓	✓	✓
New mphnavigator, mphopen, and mphload tools			✓	✓	✓
Updates to mphplot and mphgeom			✓	✓	✓
Updates to mphplot, and mphgetexpressions			✓	✓	✓
Directivity plots (Acoustics Module) and optical aberration plots (Ray Optics) with mphplot				✓	✓
Updates to mphevaluate, mphglobalmatrix, mphstate , mphmatrix, mphnavigator, and mphshowerrors				✓	✓
New mphray function for ray optics and ray acoustics data sets				✓	✓
Improved access to ray and particle data from parametric sweep studies in mphray and mphparticle				✓	✓
Support for views in the mphplot, mphgeom, and mphmesh functions				✓	✓
New mphthumbnail function for setting thumbnail images of models				✓	✓
New mphdoc function for accessing the COMSOL documentation				✓	✓
Connect to a COMSOL Multiphysics® server from MATLAB® and COMSOL Multiphysics® at the same time				✓	✓
Access to functions from the Apps tab of the MATLAB® ribbon				✓	✓
New function mphreduction for extracting reduced-order state-space matrices				✓	✓

LIVELINK™ *for* MATLAB®	4.X	5.0–1	5.2	5.3	5.4
Updates to mphplot, mphmesh, and mphthumbnail				✓	✓
Use MATLAB® function calls wherever you can use global parameters				✓	✓
Updates to mphnavigator, mphsearch, and mphmodellibrary					✓
Updates to mphplot: Layered shells, more polar plot options, and overlapping faces					✓

*mphimage2geom, mphevalpoint, mphmean, mphmin, mphmax, mphevalglobalmatrix, mphsearch, mphinputmatrix, mphsolution, mphtable, and mphparticle.

LIVELINK™ *for* EXCEL®	4.X	5.0–1	5.2	5.3	5.4
Multiple files	✓	✓	✓	✓	✓
Interpolation functions	✓	✓	✓	✓	✓
Material export	✓	✓	✓	✓	✓
Connect to remote server	✓	✓	✓	✓	✓
Export of field-dependent material properties	✓	✓	✓	✓	✓
Parametric sweeps in worksheet	✓	✓	✓	✓	✓
Create macros with Visual Basic® for Applications (VBA) development system		✓	✓	✓	✓
Localized language support		✓	✓	✓	✓
LiveLink™ *for* Excel® for class kit licenses		✓	✓	✓	✓
Save model files for VBA		✓	✓	✓	✓
Save and load spreadsheet files		✓	✓	✓	✓
Automatically synchronized values for parameters and variables			✓	✓	✓
Manage models and connections in the Microsoft® Excel® file tab				✓	✓
Context-sensitive help				✓	✓
Buttons for Results Parameters and for Clear and Evaluate All				✓	✓
Export 1D plots more easily				✓	✓