COMSOL® Software – Release Highlights History

COMSOL Multiphysics® software					
Geometry and Mesh	**4.X**	**5.0**	**5.1**	**5.2**	**5.3**
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					✓
Modeling Tools	**4.X**	**5.0**	**5.1**	**5.2**	**5.3**
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					✓
Studies and Solvers	**4.X**	**5.0**	**5.1**	**5.2**	**5.3**
Time-dependent adaptive meshing	✓	✓	✓	✓	✓
Automatic remeshing	✓	✓	✓	✓	✓
Cluster sweeps and cloud computing	✓	✓	✓	✓	✓
Multi-parameter sweeps	✓	✓	✓	✓	✓
Smoothed AMG solver				✓	✓
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					✓

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

Results and Visualization	4.X	5.0	5.1	5.2	5.3
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					✓
Application Builder	4.X	5.0	5.1	5.2	5.3
Application Builder for converting models to apps		✓	✓	✓	✓
Send e-mail from applications			✓	✓	✓
60 example applications in the Application Libraries				✓	✓
Interactive data picking in graphics					✓

COMSOL Server™ product	4.X	5.0	5.1	5.2	5.3
NEW Product: COMSOL Server™		✓	✓	✓	✓
Run apps 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™					✓

ELECTROMAGNETICS	4.X	5.0	5.1	5.2	5.3
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	✓	✓	✓	✓	✓

ELECTROMAGNETICS	4.X	5.0	5.1	5.2	5.3
NEW Product: Semiconductor Module	✓	✓	✓	✓	✓
Nonlinear magnetic material library 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					✓
Library of more than 60 RF and microwave substrate materials from Rogers Corporation					✓

HEAT TRANSFER	4.X	5.0	5.1	5.2	5.3
Multilayered shells	✓	✓	✓	✓	✓
Fans and grilles	✓	✓	✓	✓	✓
Solar irradiation	✓	✓	✓	✓	✓
Moist air and condensation	✓	✓	✓	✓	✓
Multi-wavelength radiation	✓	✓	✓	✓	✓
Phase change	✓	✓	✓	✓	✓
Thermal contact with surface roughness	✓	✓	✓	✓	✓
Multiphysics interface for the thermoelectric effect	✓	✓	✓	✓	✓
Bioheating with damage integral analysis	✓	✓	✓	✓	✓
Non-isothermal flow in porous media			✓	✓	✓
Algebraic turbulence models			✓	✓	✓
Multiphysics interface for the Marangoni effect			✓	✓	✓
Meteorological database for ambient conditions				✓	✓

HEAT TRANSFER	4.X	5.0	5.1	5.2	5.3
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					✓

STRUCTURAL MECHANICS	4.X	5.0	5.1	5.2	5.3
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		✓	✓	✓	✓
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 app					✓

STRUCTURAL MECHANICS	4.X	5.0	5.1	5.2	5.3
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					✓

ACOUSTICS	4.X	5.0	5.1	5.2	5.3
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					✓

FLUID FLOW	4.X	5.0	5.1	5.2	5.3
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					✓
All turbulence models made available for multiphase flow					✓
Rotating machinery interfaces made available for all flow interfaces					✓

CHEMICAL	4.X	5.0	5.1	5.2	5.3
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 app for optimizing batteries for specific applications					✓

See page 25 for more details

OPTIMIZATION	4.X	5.0	5.1	5.2	5.3
Parameter optimization	✓	✓	✓	✓	✓
Design optimization	✓	✓	✓	✓	✓
Gradient-based and derivative-free optimization study	✓	✓	✓	✓	✓
Multianalysis optimization		✓	✓	✓	✓
New least square fitting method				✓	✓

See page 26 for more details

PARTICLE TRACING	4.X	5.0	5.1	5.2	5.3
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					✓

INTERFACING	4.X	5.0	5.1	5.2	5.3
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	✓	✓	✓	✓	✓

COMSOL® Software – Release Details History

COMSOL MULTIPHYSICS® PLATFORM AND HARDWARE SUPPORT	4.X	5.0	5.1	5.2	5.3
General Windows®, OS X, and Linux® operating system support	✓	✓	✓	✓	✓
Run aps on all major web browsers		✓	✓	✓	✓
macOS 10.12 Sierra operating system support			✓	✓	✓
Windows® 10 operating system support			✓	✓	✓
3Dconnexion® SpaceMouse® device support					✓

COMSOL MULTIPHYSICS® MESH AND GEOMETRY	4.X	5.0	5.1	5.2	5.3
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	✓	✓	✓	✓	✓
2D 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					✓
Five new mesh quality measures					✓

COMSOL MULTIPHYSICS® MESH AND GEOMETRY	4.X	5.0	5.1	5.2	5.3
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					✓

COMSOL MULTIPHYSICS® MODELING TOOLS	4.X	5.0	5.1	5.2	5.3
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 apps			✓	✓	✓
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					✓
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					✓
App for cluster setup validation					✓
Counter for the number of selections					✓

COMSOL MULTIPHYSICS® STUDIES AND SOLVERS	4.X	5.0	5.1	5.2	5.3
Time-dependent adaptive meshing	✓	✓	✓	✓	✓
Automatic remeshing	✓	✓	✓	✓	✓
Double-dogleg nonlinear solver	✓	✓	✓	✓	✓
Cluster Sweep and Batch Sweep	✓	✓	✓	✓	✓
Multi-parameter 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					✓
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					✓

COMSOL MULTIPHYSICS® RESULTS AND VISUALIZATION	4.X	5.0	5.1	5.2	5.3
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		✓	✓	✓	✓

COMSOL MULTIPHYSICS® RESULTS AND VISUALIZATION	4.X	5.0	5.1	5.2	5.3
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					✓
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					✓

COMSOL MULTIPHYSICS® APPLICATION BUILDER	4.X	5.0	5.1	5.2	5.3
Application Builder		✓	✓	✓	✓
Convert model to app		✓	✓	✓	✓
20 example applications in Application Libraries			✓	✓	✓
Send e-mail from applications			✓	✓	✓
Support for apps 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 run time				✓	✓
Autocompletion for application objects				✓	✓

COMSOL MULTIPHYSICS® APPLICATION BUILDER	4.X	5.0	5.1	5.2	5.3
Video and hyperlink form objects				✓	✓
Unit sets for centralized unit control				✓	✓
Interactive data picking in graphics					✓
Data access in the Application Builder settings					✓
Improved toolbar for applications in a web browser					✓
Data access for physics interfaces					✓
Horizontal radio buttons					✓

COMSOL SERVER™	4.X	5.0	5.1	5.2	5.3
NEW Product: COMSOL Server™		✓	✓	✓	✓
Run apps with COMSOL Client for Windows®		✓	✓	✓	✓
Run apps with any major web browser		✓	✓	✓	✓
Allow coworkers and customers to run COMSOL applications		✓	✓	✓	✓
Fast launch of apps, app prelaunching		✓	✓	✓	✓
Configure for one app				✓	✓
Reconnect to app 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 apps 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					✓

ELECTROMAGNETICS	4.X	5.0	5.1	5.2	5.3
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 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	5.1	5.2	5.3
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 app			✓	✓	✓
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 app				✓	✓
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	5.1	5.2	5.3
Optical aberration plots				✓	✓
Electrostatics based on the boundary element method (BEM)					✓
Hybrid finite element and boundary element method 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					✓
De-embedded 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	5.1	5.2	5.3
Power-driven terminal condition for semiconductor device simulations					✓
Perfectly matched layers for Schrödinger equation analysis					✓

HEAT TRANSFER	4.X	5.0	5.1	5.2	5.3
Multilayered shells	✓	✓	✓	✓	✓
Fans and grilles	✓	✓	✓	✓	✓
External radiation sources	✓	✓	✓	✓	✓
Solar irradiation	✓	✓	✓	✓	✓
Total power heat sources	✓	✓	✓	✓	✓
Moist air and condensation	✓	✓	✓	✓	✓
Load cases	✓	✓	✓	✓	✓
Multi-wavelength 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 non-isothermal flow		✓	✓	✓	✓
Algebraic turbulence models			✓	✓	✓
Multiphysics interface for local thermal non-equilibrium			✓	✓	✓
Coupled porous media and turbulent flow			✓	✓	✓
Non-isothermal 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				✓	✓

HEAT TRANSFER	4.X	5.0	5.1	5.2	5.3
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					✓
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					✓

STRUCTURAL MECHANICS	4.X	5.0	5.1	5.2	5.3
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	✓	✓	✓	✓	✓
Buckling for trusses	✓	✓	✓	✓	✓

STRUCTURAL MECHANICS	4.X	5.0	5.1	5.2	5.3
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			✓	✓	✓
External stress interface			✓	✓	✓

STRUCTURAL MECHANICS	4.X	5.0	5.1	5.2	5.3
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 pre-stressed 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 shell and beam					✓
Rigid connector for beams					✓
Spring boundary conditions for rigid domain and connector					✓

STRUCTURAL MECHANICS	4.X	5.0	5.1	5.2	5.3
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 app					✓
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					✓

ACOUSTICS	4.X	5.0	5.1	5.2	5.3
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	✓	✓	✓	✓	✓

ACOUSTICS	4.X	5.0	5.1	5.2	5.3
Multiphysics interface for time-domain pipe acoustics	✓	✓	✓	✓	✓
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 discontinuous Galerkin					✓
Thermal and viscous losses in poroelastic waves based on 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					✓

ACOUSTICS	4.X	5.0	5.1	5.2	5.3
Incident monochromatic plane waves for transient acoustics					✓
Linear and logarithmic frequency axis option for directivity plots					✓
Improved solver suggestions for multiphysics couplings and transient analysis					✓

FLUID FLOW	4.X	5.0	5.1	5.2	5.3
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		✓	✓	✓	✓
Turbulence with grilles and fans		✓	✓	✓	✓
New multiphysics interface for non-isothermal 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			✓	✓	✓

FLUID FLOW	4.X	5.0	5.1	5.2	5.3
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					✓
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					✓

CHEMICAL	4.X	5.0	5.1	5.2	5.3
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		✓	✓	✓	✓
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				✓	✓

CHEMICAL	4.X	5.0	5.1	5.2	5.3
Multiphysics interface for electrochemical heat source				✓	✓
Thermodynamic equilibrium electrode kinetics				✓	✓
Nernst-Planck-Poisson equations interface					✓
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 app for optimizing batteries for specific applications					✓
Baker-Verbrugge diffusion model, in the Lithium-Ion Battery and Battery with Binary Electrolyte interfaces					✓

OPTIMIZATION	4.X	5.0	5.1	5.2	5.3
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				✓	✓

MATERIAL LIBRARY PRODUCT	4.X	5.0	5.1	5.2	5.3
2500 materials	✓	✓	✓	✓	✓
More than 150 new materials					✓

PARTICLE TRACING	4.X	5.0	5.1	5.2	5.3
NEW Product: Particle Tracing	✓	✓	✓	✓	✓
Particle forces: electric, magnetic, collisional, drag, gravity, acoustophoretic, dielectrophoretic, user-defined	✓	✓	✓	✓	✓
New forces: Brownian, Schiller-Naumann, magnetophoretic, 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, average over particles	✓	✓	✓	✓	✓
New accumulator tools enabling multiphysics couplings for erosion, etching, mass deposition, boundary load, mass flux, current density, 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	5.1	5.2	5.3
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					✓

INTERFACING	4.X	5.0	5.1	5.2	5.3
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	5.1	5.2	5.3
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		✓	✓	✓	✓
SOLIDWORKS® 2014 software		✓	✓	✓	✓
Autodesk® Inventor® 2015 software		✓	✓	✓	✓

NEW CAD FILE FORMATS	4.X	5.0	5.1	5.2	5.3
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					✓

LIVELINK™ for SOLIDWORKS®	4.X	5.0	5.1	5.2	5.3
One-window interface	✓	✓	✓	✓	✓
Parameter linking	✓	✓	✓	✓	✓
Sync material names	✓	✓	✓	✓	✓
Sync user-defined selections	✓	✓	✓	✓	✓
Run apps 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					✓

LIVELINK™ for INVENTOR®	4.X	5.0	5.1	5.2	5.3
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					✓

LIVELINK™ for AUTOCAD®	4.X	5.0	5.1	5.2	5.3
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					✓

LIVELINK™ for PTC® PRO/ENGINEER®	4.X	5.0	5.1	5.2	5.3
Synchronize selections for materials			✓	✓	✓
Tracking of document information including file name and file path				✓	✓

LIVELINK™ for PTC® CREO® PARAMETRIC™	4.X	5.0	5.1	5.2	5.3
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					✓

LIVELINK™ for SOLID EDGE®	4.X	5.0	5.1	5.2	5.3
Synchronize selections for materials			✓	✓	✓
Connecting to COMSOL Server™ from within the Solid Edge® interface				✓	✓
Tracking of document information including file name and file path				✓	✓

LIVELINK™ for REVIT®	4.X	5.0	5.1	5.2	5.3
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					✓

ECAD IMPORT MODULE	4.X	5.0	5.1	5.2	5.3
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					✓

LIVELINK™ for MATLAB®	4.X	5.0	5.1	5.2	5.3
Improved performance and memory handling	✓	✓	✓	✓	✓
Model navigator	✓	✓	✓	✓	✓
New functions*	✓	✓	✓	✓	✓
Updates to: mphnavigator , mpheval, mphint, mphinterp , mphplot, mphsolutioninfo, mphtable	✓	✓	✓	✓	✓

LIVELINK™ *for* MATLAB®	4.X	5.0	5.1	5.2	5.3
New client/server functionality		✓	✓	✓	✓
Updates to: mphplot		✓	✓	✓	✓
New functions: mphevaluate, mphinterpolationfile, mphwritestl, mphreadstl, mphsurf			✓	✓	✓
Updates to: mphxmeshinfo, mphmean, mphmax, mphmin, mphint2			✓	✓	✓
New mphnavigator, mphopen, and mphload tools				✓	✓
Updates to: mphplot and mphgeom				✓	✓
Updates to: mphplot, mphgetexpressions				✓	✓
Directivity plots (Acoustics Module) and optical aberration plots (Ray Optics) with mphplot					✓
Updates to: mphevaluate, mphglobalmatrix, mphstate , mphmatrix, mphnavigator, mph-showerrors					✓
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					✓
Updates to: mphplot, mphmesh, mphthumbnail					✓
Use MATLAB® function calls wherever you can use global parameters					✓

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

LIVELINK™ *for* EXCEL®	4.X	5.0	5.1	5.2	5.3
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 Excel® file tab					✓
Context-sensitive help					✓
Buttons for Results Parameters and for Clear and Evaluate All					✓
Export 1D plots more easily					✓