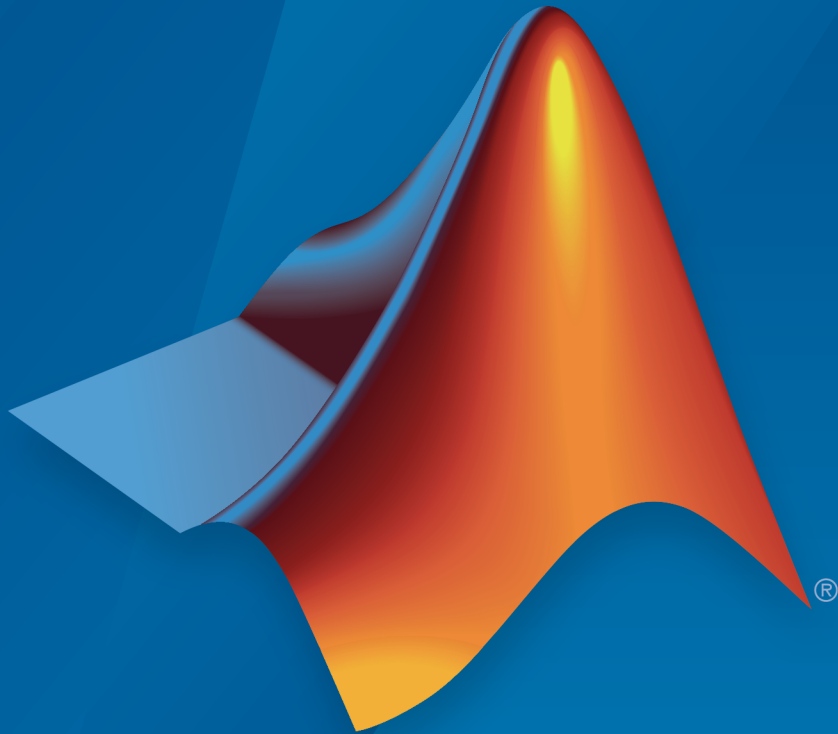


SimDriveline™ Release Notes



MATLAB® & SIMULINK®

How to Contact MathWorks



Latest news: www.mathworks.com
Sales and services: www.mathworks.com/sales_and_services
User community: www.mathworks.com/matlabcentral
Technical support: www.mathworks.com/support/contact_us



Phone: 508-647-7000



The MathWorks, Inc.
3 Apple Hill Drive
Natick, MA 01760-2098

SimDriveline™ Release Notes

© COPYRIGHT 2010–2015 by the MathWorks, Inc.

The software described in this document is furnished under a license agreement. The software may be used or copied only under the terms of the license agreement. No part of this manual may be photocopied or reproduced in any form without prior written consent from The MathWorks, Inc.

FEDERAL ACQUISITION: This provision applies to all acquisitions of the Program and Documentation by, for, or through the federal government of the United States. By accepting delivery of the Program or Documentation, the government hereby agrees that this software or documentation qualifies as commercial computer software or commercial computer software documentation as such terms are used or defined in FAR 12.212, DFARS Part 227.72, and DFARS 252.227-7014. Accordingly, the terms and conditions of this Agreement and only those rights specified in this Agreement, shall pertain to and govern the use, modification, reproduction, release, performance, display, and disclosure of the Program and Documentation by the federal government (or other entity acquiring for or through the federal government) and shall supersede any conflicting contractual terms or conditions. If this License fails to meet the government's needs or is inconsistent in any respect with federal procurement law, the government agrees to return the Program and Documentation, unused, to The MathWorks, Inc.

Trademarks

MATLAB and Simulink are registered trademarks of The MathWorks, Inc. See www.mathworks.com/trademarks for a list of additional trademarks. Other product or brand names may be trademarks or registered trademarks of their respective holders.

Patents

MathWorks products are protected by one or more U.S. patents. Please see www.mathworks.com/patents for more information.

R2015b

Variable Mass block	1-2
Variable Inertia block	1-2
Unbalanced Load block	1-2
Variable-friction tire model	1-2
Optional inertia in compound gear blocks	1-3
Number of wheels per axle parameter for Vehicle Body block	1-3

R2015a

Thermal variants for all blocks in the Gears component library	2-2
Transmissions component library with prebuilt transmission templates	2-2
Shift linkage position variant for Dog Clutch block	2-2
Featured example showing four-wheel drive test bed	2-2

R2014b

Unidirectional locking option in Disk Friction Clutch block	3-2
--------------------------------------------------------------------------	------------

R2014a

Cycloidal Drive block	4-2
Harmonic Drive block	4-2
Lookup-table friction parameterization in synchronizer blocks	4-2

R2013b

Universal Joint block	5-2
Double-Pinion Planetary Gear block	5-2
Helicopter transmission featured example	5-2

R2013a

Translational Power Sensor and Rotational Power Sensor blocks	6-2
Variable and nonlinear spring and damper component library	6-2

Shock Absorber block	6-3
Simple Gear with Variable Efficiency block	6-3
Fuel consumption and idle speed controller added to Generic Engine block	6-3
Featured examples	6-3

R2012b

Double-Shoe Brake and Band Brake blocks	7-2
Double-Sided Synchronizer and Synchronizer blocks	7-2
Rolling Resistance block for custom tire models	7-2
Optional rolling resistance in Tire (Friction Parameterized) and Tire (Magic Formula) blocks	7-2
Five-speed transmission demonstration model with individually controlled double-sided synchronizers	7-3
Four new examples	7-3

R2012a

New Blocks	8-2
New Couplings and Drives Block	8-2
New Tire Blocks	8-2
New and Updated Examples	8-2
New Examples	8-2
Updated Example	8-2

Input Filtering Usability Enhancements in SimDriveline Version 2 Transitional Library Blocks	8-3
---------------------------------------------------------------------------------------------------------------	------------

R2011b

New and Updated Blocks	9-2
New Blocks	9-2
Updated Blocks	9-2
Changes to Data Logging Object Naming	9-2
New Examples	9-2
Improved Documentation	9-3
Manual Reconstruction of Version 1 Models	9-3

R2011a

SimDriveline 2.0 Software	10-2
Required Products	10-2
Selected Version 2 Capabilities Based on Simscape Software	10-2
Selected Version 2.0 Features Compared with Version 1 Features	10-3
Features Improved in Version 2.0	10-3
Features Changed in Version 2.0	10-3
Other Changes in Version 2.0	10-4
Working with Version 1 Models and Libraries	10-4
Converting Models and Libraries from Version 1 to Version 2	10-5
Accessing Version 1	10-5
Accessing the Version 1 Library	10-5

Accessing the Version 1 Examples	10-5
Accessing the Version 1 Documentation	10-5

R2015b

Version: 2.9

New Features

Bug Fixes

Variable Mass block

Model the effects of a time change in mass, such as that due to the fueling and loading of a vehicle. The **Variable Mass** block accounts for the time-varying inertia force that resists translational acceleration in driveline systems or components.

A physical signal port enables you to specify the mass value as a function of time. A minimum mass parameter ensures the variable mass is always positive and cannot fall below zero. The new block appears under a new library named **Inertias & Loads**.

Variable Inertia block

Model the effects of a time change in inertia, such as that due to the buildup of mud in a tire. The **Variable Inertia** block accounts for the time-varying inertia torque that resists rotational acceleration in driveline systems or components.

A physical signal port enables you to specify the inertia value as a function of time. A minimum inertia parameter ensures the variable inertia is always positive and cannot fall below zero. The new block appears under a new library named **Inertias & Loads**.

Unbalanced Load block

Model the effects of a load whose rotational inertia varies instantaneously with the rotation angle. Examples include the wobbling of a spinning axle and shaking of an off-center rotating machine. You can specify the load inertia in terms of its rotation path or as an angle-inertia lookup table. The **Unbalanced Load** block appears under a new library named **Inertias & Loads**.

Variable-friction tire model

Model the effects of a changing road-tire friction coefficient, for example, due to an encounter with an ice patch or water puddle. The following **Tire** blocks now provide variable-friction variants:

- **Tire (Friction Parameterized)**
- **Tire (Magic Formula)**
- **Tire-Road Interaction (Magic Formula)**

To switch between tire variants, right-click the **Tire** block and, under **Simscape > Block choices**, select the desired tire model. When using variable-friction tire variants, avoid

sudden changes to the friction coefficients, as these can cause numerical issues in the model.

Optional inertia in compound gear blocks

Specify the inertias of internal gears in compound gear blocks, for example, to account for inertia torques during rapid changes in rotation direction or speed. You can specify the inertia of internal gears explicitly in a new dialog box tab named Inertia. The following blocks provide the new tab:

- Compound Planetary Gear
- Differential
- Planetary Gear
- Ravigneaux Gear

Each block provides an inertia parameter for at least one internal gear node. Planetary Gear and Compound Planetary Gear blocks contain one such node while Differential and Ravigneaux Gear blocks contain two. You can ignore internal gear inertias by setting their values to zero.

Number of wheels per axle parameter for Vehicle Body block

Model vehicles with different numbers of wheels in their front and rear axles. Examples include three-wheeled forklifts with two wheels in the front axle and one wheel in the rear axle. The `Vehicle Body` block now enables you to enter the numbers of wheels in the two axles separately as a two-element vector. The first element corresponds to the front axle and the second element to the rear axle. Entering a scalar instead of a two-element vector causes the two wheel numbers to be the same.

R2015a

Version: 2.8

New Features

Bug Fixes

Thermal variants for all blocks in the Gears component library

Gear blocks now include thermal variants, alternative block implementations that account for heat generation due to meshing, changes in gear efficiency due to temperature fluctuations, and the impact of a gear's thermal mass on those temperature fluctuations.

You can switch between gear variants in the block's context-sensitive menu. You do this by right-clicking the gear block and selecting **Simscape > Block choices > Show thermal port** to model thermal effects, or **Simscape > Block Choices > No thermal port** to ignore those thermal effects.

Transmissions component library with prebuilt transmission templates

A new Transmissions library provides prebuilt transmission templates—subsystem models built on SimDriveline and Simscape blocks that represent various transmission types.

Use the templates to quickly model 4- to 9- speed transmissions, including CR-CR, Ravigneaux, and Lepelletier systems. Each template contains a clutch schedule that determines which clutches must engage and disengage in order to reach a certain gear.

Shift linkage position variant for Dog Clutch block

The Dog Clutch block now includes a variant that accepts the linkage position directly as a physical signal input instead of through a translational conserving port. The new variant provides a convenient means of specifying the shift linkage position when the position signal arises from a control system.

You can switch between variants in the block's context-sensitive menu. You do this by right-clicking the block and selecting **Simscape > Block choices > Physical signal position input** to use a physical signal port or **Simscape > Block choices > Mechanical port shift linkage** to use a translational conserving port.

Featured example showing four-wheel drive test bed

A new featured example shows how to model the dynamics of a four-wheel drive testbed.

R2014b

Version: 2.7

New Features

Bug Fixes

Unidirectional locking option in Disk Friction Clutch block

The Disk Friction Clutch block includes a new parameter, **Directionality**. This parameter enables you to model bidirectional and unidirectional clutches. Bidirectional clutches can slip in the positive and negative directions while unidirectional clutches can slip only in the positive direction. The slip direction is positive if the follower shaft spins faster than the base shaft and negative if it spins slower.

R2014a

Version: 2.6

New Features

Bug Fixes

Cycloidal Drive block

Model a high-ratio speed-reduction mechanism based on the eccentric motion of a cycloidal disk in mesh with a ring gear. The Cycloidal Drive block includes efficiency losses in normal and reverse operation modes. This block is in the Gears library.

Harmonic Drive block

Model a high-ratio speed-reduction mechanism based on the elastic deformation of a flexible pinion in mesh with a ring gear. The Harmonic Drive block includes efficiency losses due to meshing between teeth and viscous friction at the ball bearings. This block is in the Gears library.

Lookup-table friction parameterization in synchronizer blocks

Compute contact friction in synchronizer blocks using a lookup-table parameterization. You can select the new parameterization from the Cone Clutch tab of the Synchronizer and Double-Sided Synchronizer block dialog boxes.

R2013b

Version: 2.5

New Features

Bug Fixes

Universal Joint block

The SimDriveline™ Couplings & Drives library provides one new block, Universal Joint. This block represents a rotational coupling that connects two driveline shafts at an arbitrary angle.

Double-Pinion Planetary Gear block

The SimDriveline Gears library provides one new block, Double-Pinion Planetary Gear. This block represents a planetary gear train containing two meshed planet gear sets between its sun and ring gears.

Helicopter transmission featured example

A new featured example models the dynamics of a helicopter transmission system.

R2013a

Version: 2.4

New Features

Bug Fixes

Translational Power Sensor and Rotational Power Sensor blocks

SimDriveline contains a new library, Sensors. The library contains two blocks.

Block	Description
Translational Power Sensor	Mechanical sensor used to measure average or instantaneous translational power
Rotational Power Sensor	Mechanical sensor used to measure average or instantaneous rotational power

Variable and nonlinear spring and damper component library

The Couplings & Drives library contains a new sublibrary, Springs & Dampers. The sublibrary contains eight blocks.

Block	Description
Nonlinear Translational Spring	Translational spring with nonlinear force-displacement curve
Nonlinear Translational Damper	Translational damper with nonlinear force-velocity curve
Nonlinear Rotational Spring	Rotational spring with nonlinear torque-displacement curve
Nonlinear Rotational Damper	Rotational damper with nonlinear torque-velocity curve
Variable Translational Spring	Translational spring with variable spring stiffness
Variable Translational Damper	Translational damper with variable damping coefficient
Variable Rotational Spring	Rotational spring with variable spring stiffness
Variable Rotational Damper	Viscous rotational damper with variable damping coefficient

Shock Absorber block

The Couplings & Drives library contains one new block.

Block	Description
Shock Absorber	Linear spring-damper with friction and hard stops

Simple Gear with Variable Efficiency block

The Gears library contains one new block.

Block	Description
Simple Gear with Variable Efficiency	Simple gear with externally specified meshing efficiency

Fuel consumption and idle speed controller added to Generic Engine block

The Generic Engine block contains new options:

- Specify and sense engine fuel consumption
- Specify an idle speed controller to prevent engine stall at low engine speeds

Featured examples

Three new featured examples are available:

- Engine Braking
- Simpson Three-Speed Transmission
- Suspension System Comparison

R2012b

Version: 2.3

New Features

Bug Fixes

Double-Shoe Brake and Band Brake blocks

SimDriveline adds two blocks to the Brakes and Detents library:

Block	Description
Double-Shoe Brake	Friction brake with two diametrically opposed rigid shoes positioned about a rotating drum
Band Brake	Friction brake with a flexible band wrapped around a rotating drum

Double-Sided Synchronizer and Synchronizer blocks

SimDriveline adds two blocks to the Clutches library:

Block	Description
Synchronizer	Clutch synchronizer with one dog clutch, one cone clutch, and one detent
Double-Sided Synchronizer	Double-sided clutch synchronizer with two dog clutches, two cone clutches, and one detent

Rolling Resistance block for custom tire models

SimDriveline adds one block to the Tires & Vehicles Library:

Block	Description
Rolling Resistance	Resistance force due to road-wheel contact

Optional rolling resistance in Tire (Friction Parameterized) and Tire (Magic Formula) blocks

The Tire (Friction Parameterized) and Tire (Magic Formula) blocks introduce an optional set of rolling resistance parameters. Represent tire rolling resistance with a constant resistance coefficient or with a pressure and velocity dependent model that meets the SAE J2452 standard.

Five-speed transmission demonstration model with individually controlled double-sided synchronizers

A new example demonstrates a five-speed transmission model. The model contains five forward gears and one reverse gear driven by an engine. Proportional control systems govern a set of double-sided synchronizers that engage each gear with an output shaft.

Four new examples

SimDriveline introduces four examples:

- Five-Speed Transmission (highlighted above)
- Reversing Transmission
- Hydromechanical Hoist
- Braking Mechanism

R2012a

Version: 2.2

New Features

Bug Fixes

Compatibility Considerations

New Blocks

New Couplings and Drives Block

Block	Description
Belt Drive	Model a belt drive
Belt Pulley	Model a belt pulley
Chain Drive	Model a chain drive
Rope Drum	Model a rope drum

New Tire Blocks

Block	Description
Tire (Friction Parameterized)	Model a tire using kinetic and static friction coefficients
Tire (Simple)	Model a no-slip tire with minimal parameters

New and Updated Examples

New Examples

Example	Description
Stepping Mechanism with Detents sdl_stepping_mechanism_with_detents	Models a stepping mechanism, including using Translational Detent blocks.
Power Window System sdl_power_window	Models a power window system, including using the new Rope Drum and Belt Pulley blocks.
Sheet Metal Feeder sdl_sheet_metal_feeder	Models the feeding mechanism of a sheet metal cutter, including the use of the Loaded Contact Translational Friction block.

Updated Example

The “Vehicle with Four-Wheel Drive” example (sdl_4wd_dynamics) now uses Simulink[®] subsystem variants to allow testing with several different tire models.

Input Filtering Usability Enhancements in SimDriveline Version 2 Transitional Library Blocks

SimDriveline Version 2 Transitional library blocks that accept Simulink inputs now have an **Input Handling** tab. You can choose between no filtering, first-order filtering, and second-order filtering with a time constant that you specify. For more information, see Input Handling Options in Version 2 Transitional Library Blocks.

Some Transitional library blocks have multiple Simulink input ports. Changing the settings under the **Input Handling** tab affects all Simulink input ports equally.

Simulink-PS Converter blocks provide input handling options in Transitional library blocks. The SimDriveline software uses these Simscape™ blocks in the architecture of the Transitional library blocks. These blocks exist behind a mask. For more information, see Input Filtering Usability Enhancements and Simulink-PS Converter in the Simscape documentation.

Note: In the Version 2 Transitional library, the Motion Actuator block does not require an acceleration input. The input port is still present to provide a consistent block interface, but it no longer uses an acceleration signal. For more information, see version 2 transitional library.

Compatibility Considerations

When using an explicit Simulink solver in a SimDriveline Version 2 model, you must specify a sufficient number of input derivatives in the **Input Handling** tab. Failure to do so results in an error.

R2011b

Version: 2.1

New Features

Compatibility Considerations

New and Updated Blocks

New Blocks

These blocks have been added in Version 2.1.

- Flexible Shaft
- Rotational Detent
- Translational Detent

Updated Blocks

These blocks have been improved in Version 2.1.

Block	Enhancement
Generic Engine	Simulation diagnostics added
Torque Converter	Additional parameterization options
Variable Ratio Transmission	Simulation diagnostics added

Changes to Data Logging Object Naming

If you log data in a SimDriveline model using the Simscape data logging feature, some internal node and subcomponent names will change when you log data from an unchanged model using SimDriveline 2.1, as compared with Version 2.0.

These changes enhance your understanding of the internal structure of SimDriveline models, as reflected in the data logging object.

Compatibility Considerations

If you have written a script that depends on the specific names of nodes and subcomponents in SimDriveline data logging objects, you need to update your script so that it conforms with the new naming scheme.

New Examples

The new version contains four new examples illustrating how to model hybrid (gasoline-electric) transmissions with SimDriveline software.

-
- `sdl_power_split_hybrid`
 - `sdl_parallel_hybrid`
 - `sdl_series_hybrid`
 - `sdl_dual_mode_hybrid`

Improved Documentation

Manual Reconstruction of Version 1 Models

The reference chapter on working with legacy Version 1 models and libraries has been expanded with a new section on how to rebuild Version 1 models in Version 2 without automatic conversion. See Manual Reconstruction of Version 1 Models in Version 2 in Relationship of Version 1 and Version 2.

R2011a

Version: 2.0

New Features

Compatibility Considerations

SimDriveline 2.0 Software

SimDriveline 2.0 is a new version of an existing product in the Physical Modeling family that models and simulates drivetrain systems. The new version is fully integrated with Simscape software and supports physical connections, physical signals, data logging, local solvers, and other Simscape features. At the same time, this new version extends the Simscape library with additional rotational and translational mechanical components.

With SimDriveline software, you can model bodies rotating around and translating along multiple axes, connect them with gears, and create powertrains with clutches, transmissions, and other dynamic elements and subsystems. SimDriveline software also lets you actuate and measure torques, forces, and motion. You can model, simulate, analyze, and control the motion of complex drivetrains.

SimDriveline 2.0 also includes:

- Components that couple rotational and translational motion.
- Gears with optional friction loss.
- Clutches using Coulomb friction that lock and unlock.
- Improved algorithms for simulation of redundant dynamic constraints.
- A translator function to convert Version 1 models and user-defined libraries to be compatible with the new Version 2 product library.

Required Products

SimDriveline software is an extension of the Simscape product and requires these products:

- MATLAB®
- Simulink
- Simscape

Selected Version 2 Capabilities Based on Simscape Software

For an introduction to Simscape blocks, modeling, and simulation, consult the *Simscape Getting Started Guide*.

For learn more about the Simscape features that improve how you model and simulate driveline systems, see these sections of the *Simscape User's Guide*:

-
- Basic Principles of Modeling Physical Networks.
 - Data Logging.
 - Setting Up Solvers for Physical Models and Customizing Solvers for Physical Models.

To learn how to define Simscape based blocks programmatically, see the *Simscape Language Guide*.

For details on Simscape mechanical and utility blocks that replace certain Version 1 blocks, see the block categories in the *Simscape Reference*.

Selected Version 2.0 Features Compared with Version 1 Features

Features Improved in Version 2.0

- Efficiency and other frictional losses in Version 2 gears.

These loss features are now built into the gear blocks. MathWorks recommends that you select adaptive zero-crossing in the Configuration Parameters menu of models that include gears with efficiency loss.

- Data logging without sensors.

Version 2 supports the Simscape data logging capability.

- Simscape fixed-step local solver now supported.

You can use a separate local, fixed-step solver on physical networks in Version 2 models.

- Redundant dynamic constraints now solved without errors.

In Version 2 models, when ideal clutches lock and carry the same load, the load is now distributed between the clutches without generating simulation errors.

Features Changed in Version 2.0

- Certain mechanical rotational components in the Version 1 library now provided by the Simscape Foundation library, in its mechanical and utilities sublibraries.

These equivalent components include Solver Configuration, Inertia, various sensors and sources, and simple rotational mechanisms.

- Direct connection to other Simscape components.

You can directly connect Version 2 blocks to other components based on Simscape software, without an interface component, as long as you respect the Simscape rules concerning physical ports and connections. SimDriveline driveline ports and connection lines are now mechanical conserving rotational or translational ports and physical connection lines.

- Motion initial conditions set in Version 2 Inertia and Mass blocks.

In Version 1, you set initial conditions in a separate block.

- Simulink variable-step solvers for variable-step simulation.

Version 2 is compatible with all Simulink solvers. For variable-step simulation, MathWorks recommends that you select `ode23t` or `ode15s` in your model Configuration Parameters menu.

Other Changes in Version 2.0

- Version 2 generated code simulation is slower than with Version 1.
- Tunable parameters are not supported with the SimDriveline 2 libraries.

Changing block parameter values for simulating with generated code requires changing those parameter values in the block dialog boxes and regenerating the code from the model. A workaround is:

- 1** Create your own versions of the blocks using the Simscape language.
- 2** Make the parameters that you want to tune into signal inputs by defining the input values as Simulink Constant blocks.
- 3** Convert these Simulink constant signals into physical signals with Simulink-PS Converter blocks.
- 4** Tune the Constant block values during the simulation.

Working with Version 1 Models and Libraries

Compatibility Considerations

Block diagrams built from Version 1 and block diagrams built from Version 2 can coexist in the same model or library. You can indirectly connect Version 1 block diagrams and Version 2 block diagrams using Version 1 Rotational Coupling interface blocks. You cannot connect them directly.

You can continue to create and use Version 1 models and libraries, separately from Version 2 models and libraries.

Converting Models and Libraries from Version 1 to Version 2

Optionally, you can convert models and user-defined libraries from Version 1 to Version 2 with a model conversion utility, accessed through the `sdl_update` function. This utility creates new models and user-defined libraries with Version 1 components replaced by new versions using a transitional library that is based on the SimDriveline 2 and Simscape libraries.

For more information on conversion, see the `sdl_update` function reference page and Relationship of Version 1 and Version 2.

Accessing Version 1

The Version 1 library and documentation are included with Version 2.

Accessing the Version 1 Library

To open the Version 1 library, at the command line, enter `drivelib` or `driveline`.

Accessing the Version 1 Examples

To view a list of the Version 1 example models, do one of the following:

- In the Help browser, on the Version 1 SimDriveline product roadmap page, click the product examples link.
- At the command line, enter `help drivedemos`.

If you use the command line, the examples list appears at the command line. If you click a linked individual example model name, information about that model appears at the command line.

Accessing the Version 1 Documentation

To access the Version 1 documentation, access the online version of the Version 2 release notes through the Help browser or at the MathWorks Web site, www.mathworks.com.

