Introduction to MATLAB and Simulink

About TechSource Systems

- Incorporated in 1996

- Sole distributor in Southeast Asia for The MathWorks, Inc., developer of the MATLAB® and Simulink® family of products

- Committed to empower the engineering and R&D community by providing the ultimate computing environment for technical computation, design, simulation, visualization and implementation.

- Currently have offices in Singapore (HQ), Vietnam, Malaysia, Thailand and Philippines

- At our Singapore HQ office, we are ISO 9001:2008 certified and has been awarded the Singapore's Outstanding Enterprise Award since 2013.

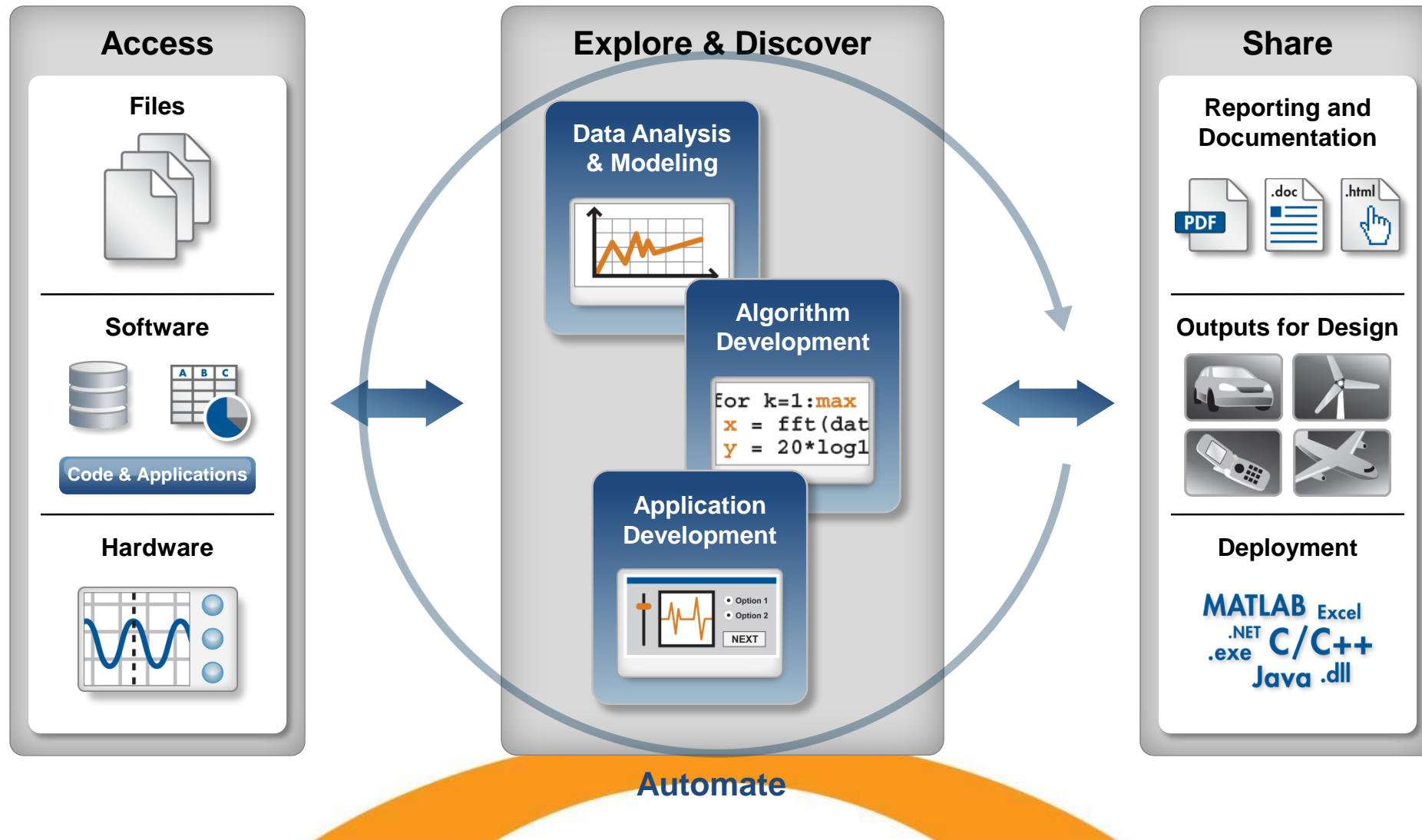# Are you ready for the class?

How to access MATLAB Online?

- MATLAB Online provides access to MATLAB from any standard web browser wherever you have internet access – just sign in to your MathWorks account.

- If you do not have a MathWorks account yet, go to **www.mathworks.com** website and click on **Sign In** at the top right corner of the page. In the page that appears, click on **Create account** at the bottom.

- While creating the account, provide your institutional email ID in order to access your organization's MATLAB license.

- Once the account is created, make sure that the account is associated with your organizational license.

- For this, sign in to **mathworks.com and** click on **My Account** when you see the drop down menu from your name on the top right, this will tell you what licenses you are already associated with.

- In the same page (**mathworks.com-> My Account**), you can see a hyperlink to **MATLAB Online** on the left hand side. Click on that to open MATLAB Online.

Agenda

- Technical Computing Workflow

- What can you do with MATLAB?

- Why MATLAB?

- What is MATLAB Live Editor?

- What is Simulink?

- MathWorks Product Overview

- What's up next?

- MATLAB Resources

Technical Computing Workflow

Access

Files

Software

Code & Applications

Hardware

Explore & Discover

Data Analysis & Modeling

Algorithm Development

```
for k=1:max
x = fft(dat
y = 20*log1
```

Application Development

- Option 1
- Option 2

NEXT

Share

Reporting and Documentation

PDF   .doc   .html

Outputs for Design

Deployment

MATLAB Excel
.NET C/C++
.exe
Java .dll

Automate

What can you do with MATLAB?

https://www.mathworks.com/videos/technical-computing-with-matlab-69042.html

- High-level language
- Interactive development environment
- Used for:
  - Numerical computation
  - Data analysis and visualization
  - Algorithm development and programming
  - Application development and deployment
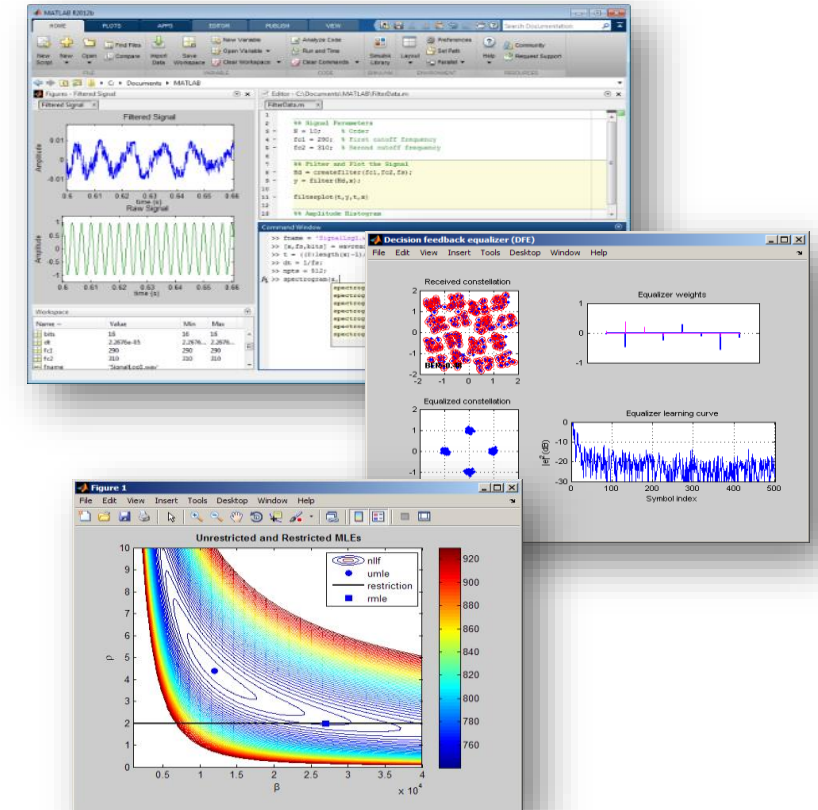
Why MATLAB?

1. MATLAB Speaks Math

```
% Create row vector
>> row = [1 2 3]
row =
     1     2     3

% Transpose
>> col = row';

% Compute inner product
>> inner = row*col
inner =
    14

% Compute outer product
>> outer = col*row
outer =
     1     2     3
     2     4     6
     3     6     9
```

Using MATLAB to solve a system of Linear Equations

System of Equations

$V_1 = i_1 * R_1 + (i_1 - i_2) * R_4$

$0 = i_2 * R_2 + (i_2 - i_3) * R_5 + (i_2 - i_1) * R_4$

$-V_2 = i_3 * R_3 + (i_3 - i_2) * R_5$

Circuit Diagram
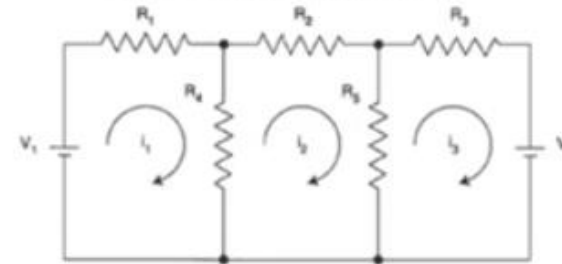
Rewritten Equations

$i_1*(R_1+R_4) - i_2*R_4 + i_3*0 = V_1$

$-i_1*R_4 + i_2*(R_2+R_5+R_4) - i_3*R_5 = 0$

$i_1*0 - i_2*R_5 + i_3*(R_3+R_5) = -V_2$

Matrices

$$\begin{matrix} A \\ \begin{pmatrix} R_1+R_4 & -R_4 & 0 \\ -R_4 & R_2+R_4+R_5 & -R_5 \\ 0 & -R_5 & R_3+R_5 \end{pmatrix} \end{matrix} \begin{matrix} X \\ \begin{pmatrix} i_1 \\ i_2 \\ i_3 \end{pmatrix} \end{matrix} = \begin{matrix} b \\ \begin{pmatrix} V_1 \\ 0 \\ -V_2 \end{pmatrix} \end{matrix}$$

System of equations

$$
\begin{pmatrix}
R_1+R_4 & -R_4 & 0 \\
-R_4 & R_2+R_4+R_5 & -R_5 \\
0 & -R_5 & R_3+R_5
\end{pmatrix}
\begin{pmatrix}
i_1 \\
i_2 \\
i_3
\end{pmatrix}
=
\begin{pmatrix}
V_1 \\
0 \\
-V_2
\end{pmatrix}
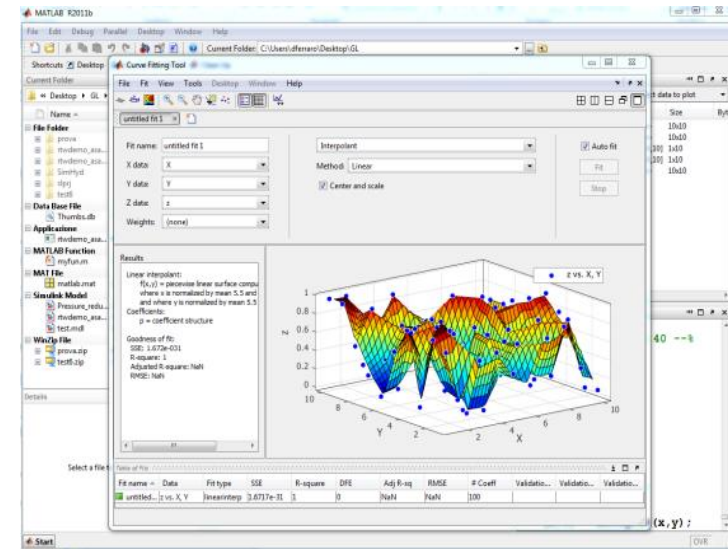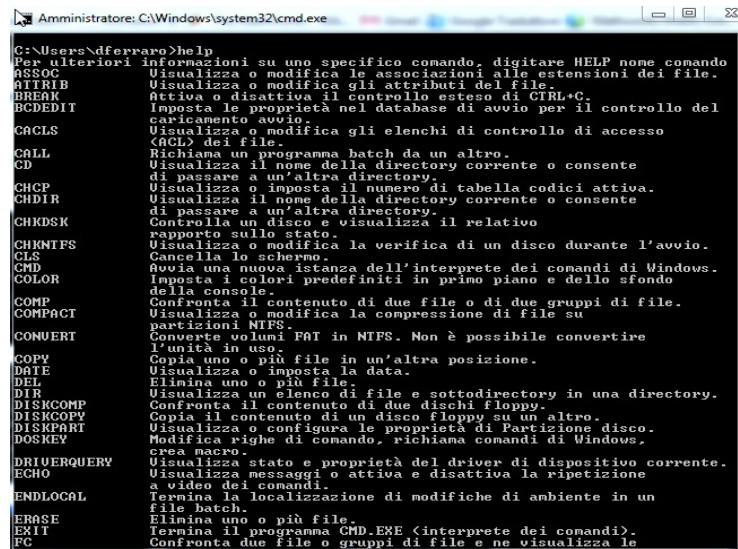$$

Solution: CircuitAnalysis.mlx

MATLAB code

```matlab
% Define resistances in ohms and voltages in volts
R1 = 100; R2 = 200; R3 = 300; R4 = 400; R5 = 500;
V1 = 10; V2 = 5;

% Define the system of equations
A = [R1+R4, -R4, 0; -R4, R2+R4+R5, -R5; 0,-R5,R3+R5];
b = [V1; 0; V2];

% Solve for x in Ax = b
x = A\b;

% Find the currents in ampere
i1 = x(1);
i2 = x(2);
i3 = x(3);
```
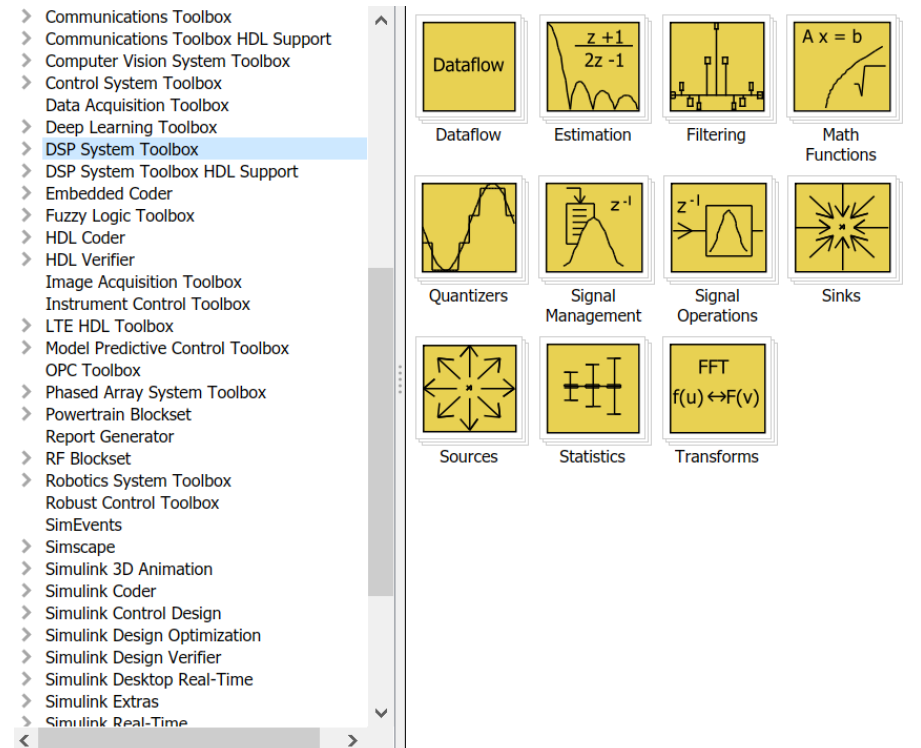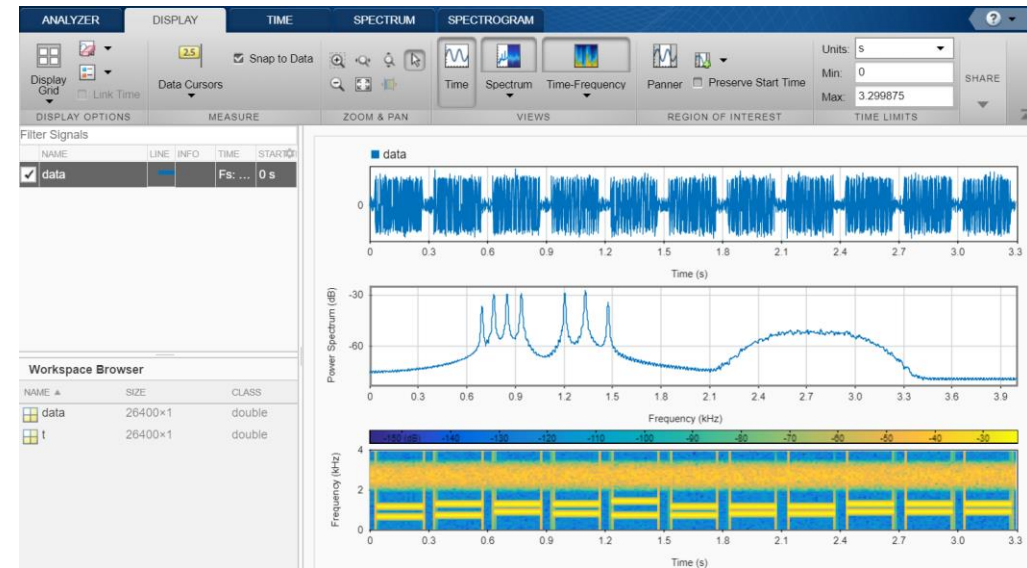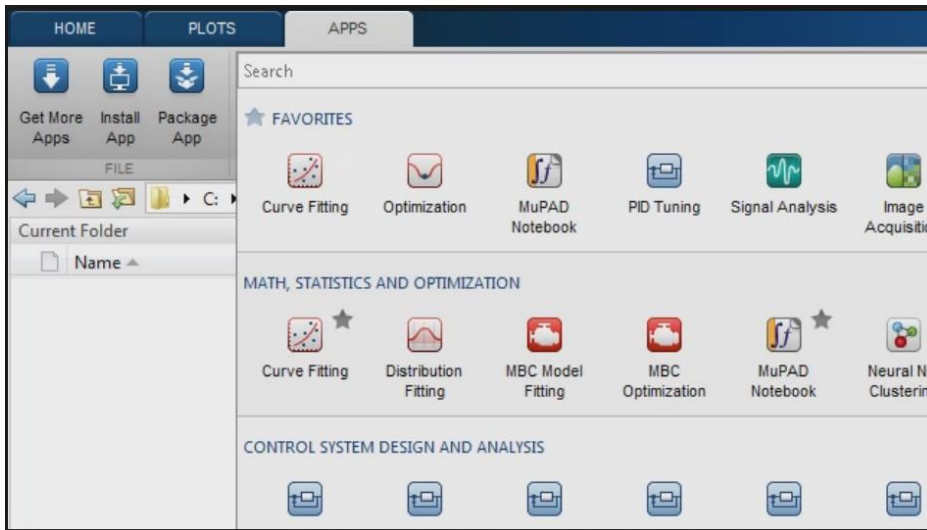
2. MATLAB is designed for Engineers and Scientists

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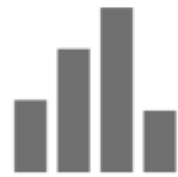# 3. MATLAB Toolboxes Just Work

4. MATLAB Has Apps

5. MATLAB Integrates Workflows

CONNECT
Use MATLAB with over 1,000 common hardware devices.

ANALYZE
Integrate MATLAB into your production analytics applications.

SCALE
Run algorithms faster and with big data by scaling up to clusters, the cloud, and GPUs.
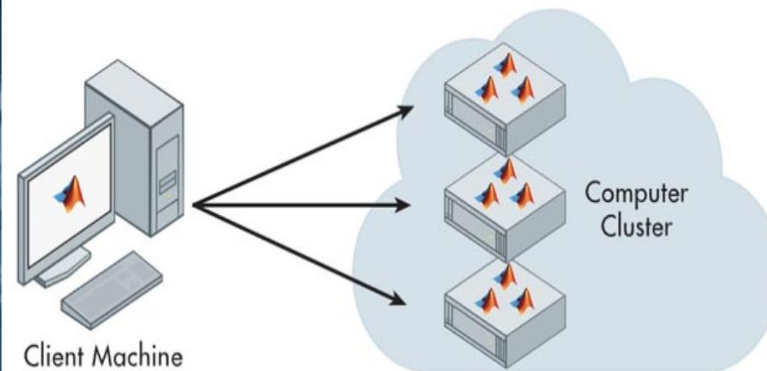
SIMULATE
Plug into Simulink and Stateflow for simulation and Model-Based Design.

EMBED
Convert MATLAB code to embeddable C and HDL code.

6. MATLAB makes Parallel Computing Easy


```
matlabpool open 2 % can adjust according to your resources

N = 100;
M = 200;
a = zeros(N,1);

tic;    %  serial (regular) for-loop
for i = 1:N
    a(i) = a(i) + max(eig(rand(M)));
end
toc;

tic;    %  parallel for-loop
parfor i = 1:N
    a(i) = a(i) + max(eig(rand(M)));
end
toc;

matlabpool close
```
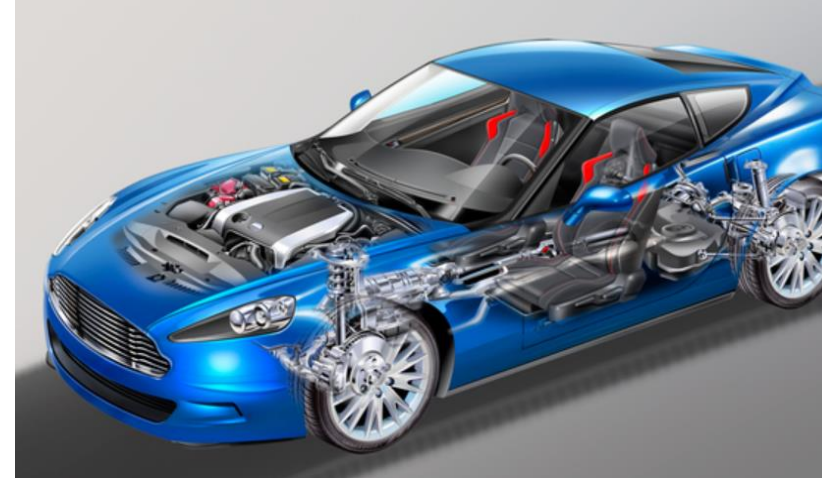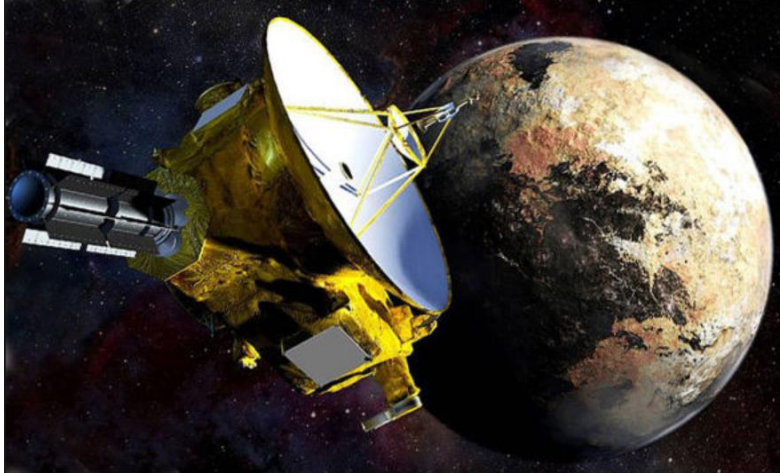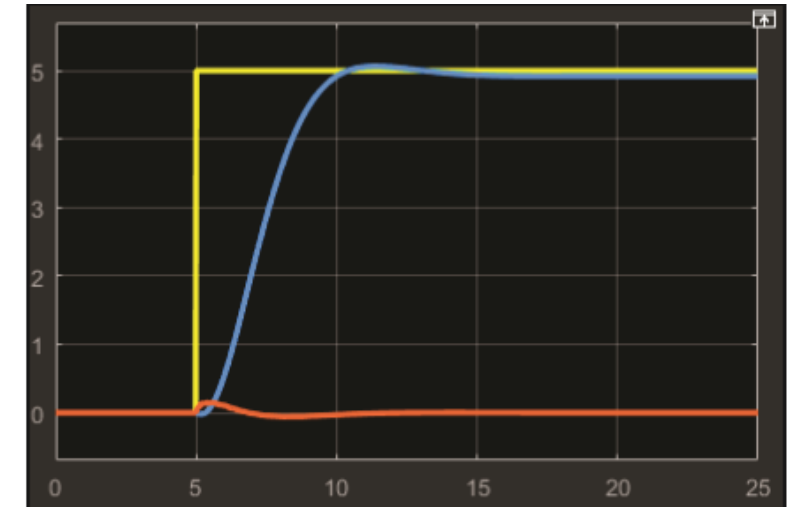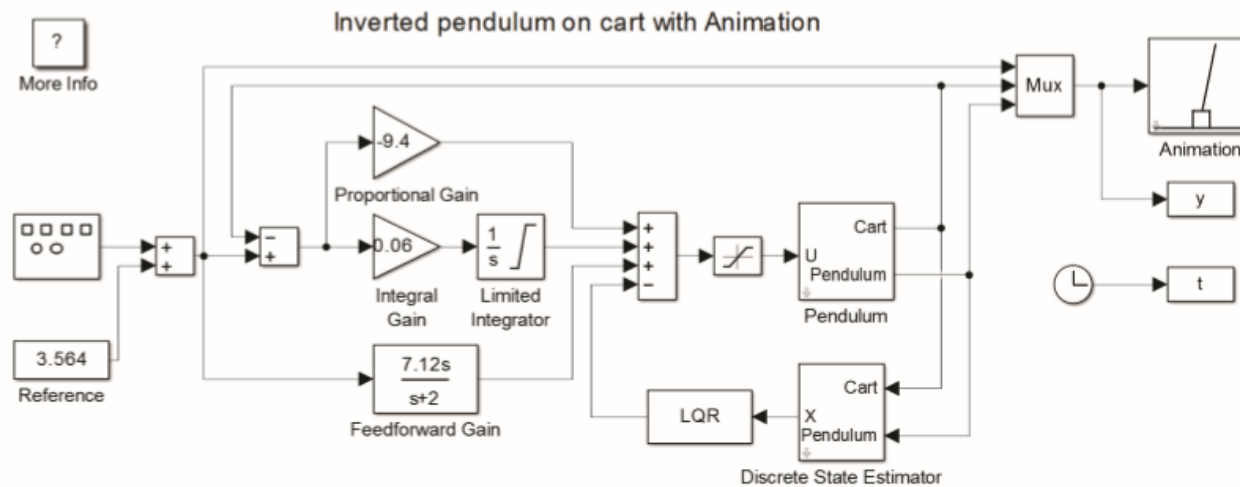
https://www.mathworks.com/products/parallel-computing.html

7. MATLAB Is Trusted

What is Simulink?
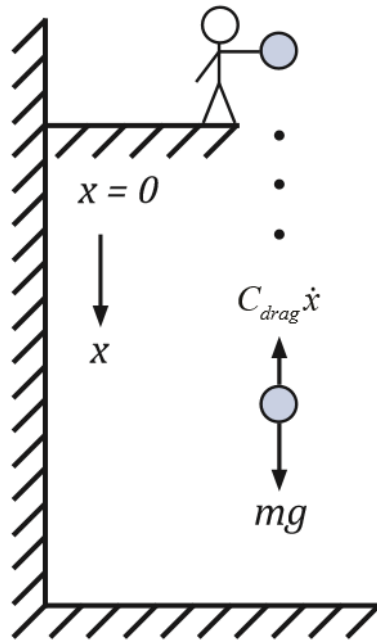
https://www.mathworks.com/videos/simulink-overview-61216.html

- Block diagram environment

- Model, simulate, visualize and validate dynamic systems

- Extensive set of built-in library blocks

- Automatic code generation

Modelling a falling ball in Simulink

$$m\ddot{x} = F_{gravity} + F_{friction}$$

$$\boxed{m\ddot{x} = mg - C_{drag}\,\dot{x}}$$

$m = 1$	$m = 1$
$C_{drag} = 1$	$C_{drag} = 1$
$g = 9.81$	$g = 9.81$
$x_0 = 0$	$x_0 = 0$
$\dot{x}_0 = 0$	$\dot{x}_0 = -50$

Solution
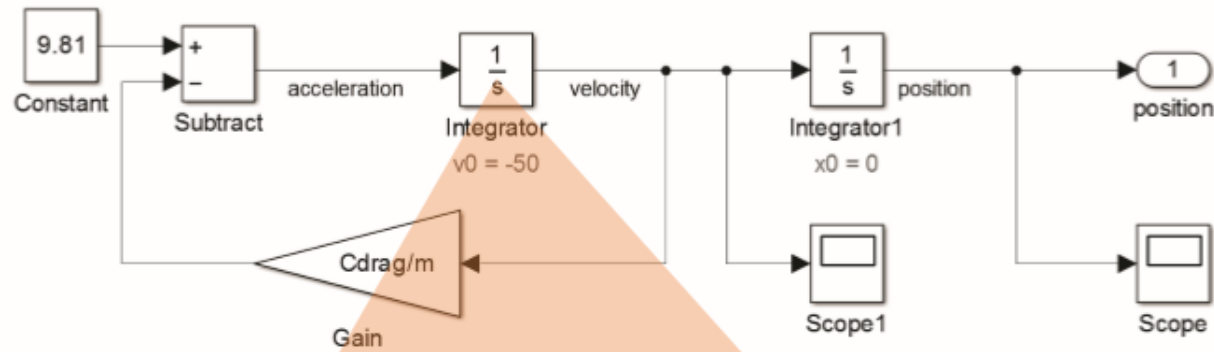
MathWorks Product Overview

Event-Based Modeling

Physical Modeling

Rapid Prototyping, and HIL Simulation

Verification, Validation, and Test

Simulation Graphics and Reporting

SIMULINK®
Simulation and Model-Based Design

Parallel Computing

Code Generation

MATLAB®
The Language of Technical Computing

Math, Statistics, and Optimization

Application Deployment

Database Access and Reporting
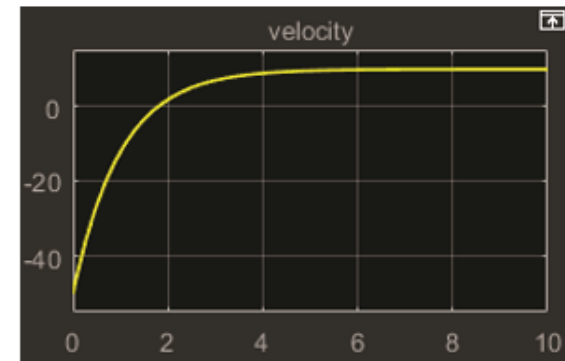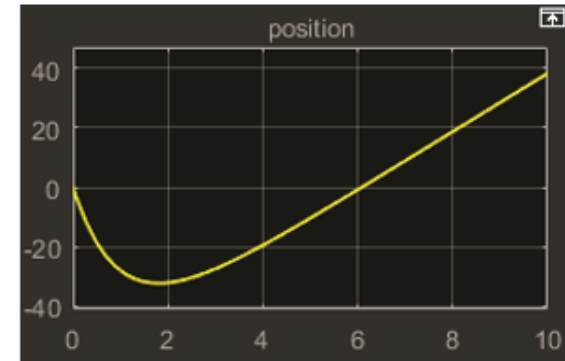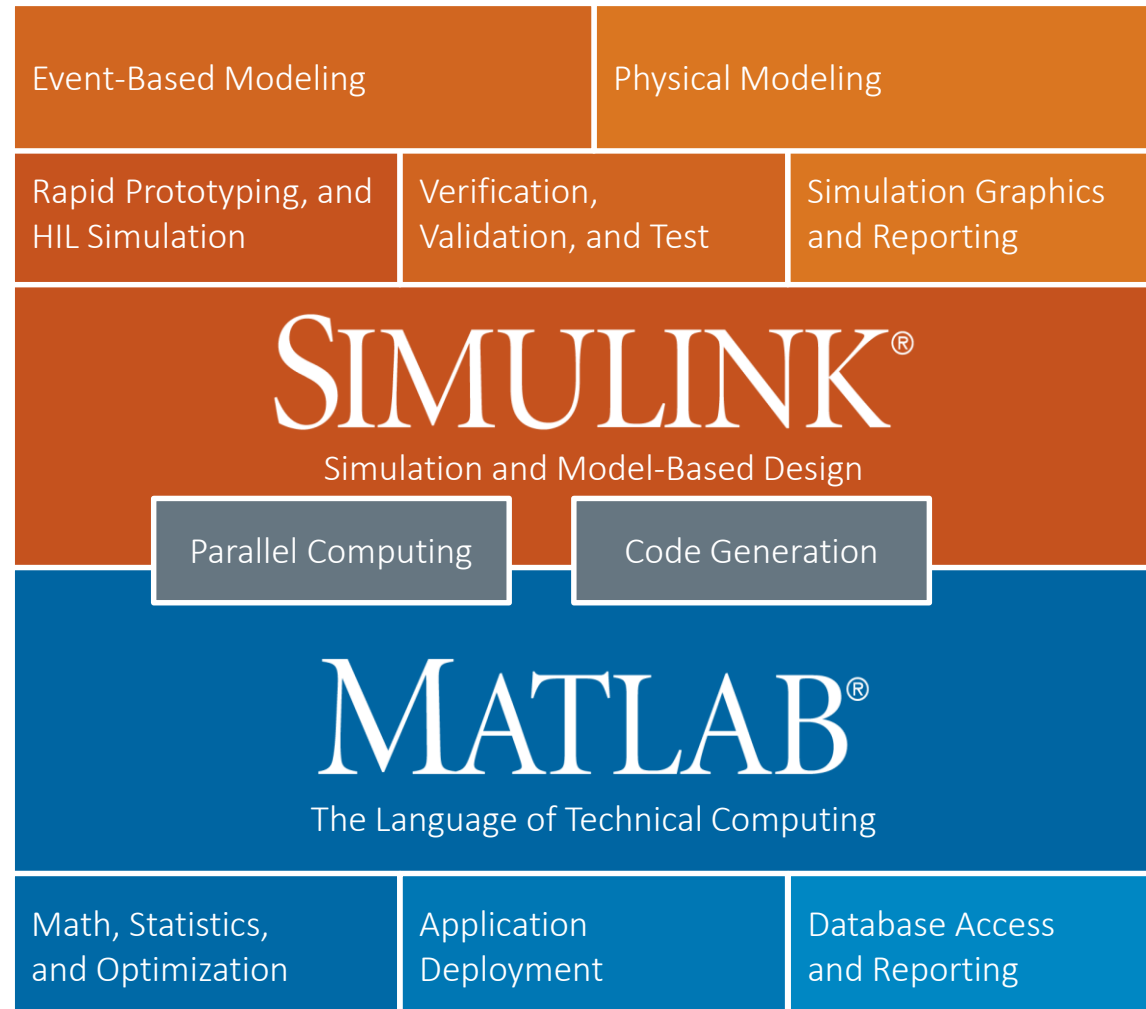
Applications

Control Systems

Signal Processing and Communications

Image Processing and Computer Vision

Test and Measurement

Computational Finance

Computational Biology

MATLAB Resources

MATLAB Central is a forum where registered users share success stories, test theories, and interact with MathWorks technical experts and each other.

www.mathworks.com/matlabcentral

MATLAB Academia is where you can get MATLAB courseware. Consists of downloadable sets of curriculum materials for educators to help you develop and enhance curriculum, facilitate lectures and classroom examples, and inspire student learning.

http://www.mathworks.com/academia

Makerzone: Join the community of makers using MATLAB, Simulink, Arduino, Raspberry Pi, LEGO MINDSTORMS robots.

http://makerzone.mathworks.com/

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Dynamic Solutions. Precise Results.