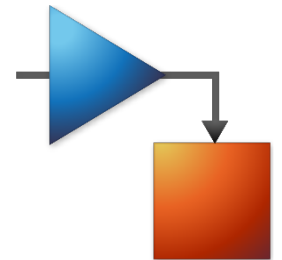
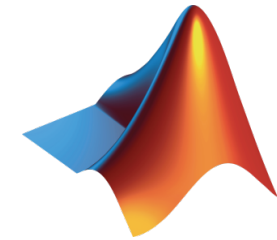


# Teaching and Learning with MATLAB & Simulink in the Modern Classroom



# Airbus

Saved three months of development time on the A380, the world's largest passenger jet





# Pre-Collision Braking System

## Advanced Driver-Assistance Systems

Critical safety features for everyone

Detects obstacles, applies brakes, adjusts cruise control, and stays in lane



EyeSight





## Robotic Prosthetics

Drumsticks controlled by flexing muscles and artificial intelligence

Patient can play **faster, more complex rhythms** than a typical human drummer



# Where are MathWorks' products used...

<https://www.mathworks.com/solutions.html>

## By Capability

Data Acquisition  
Data Analysis  
Mathematical Modeling  
Algorithm Development  
Parallel Computing  
Desktop and Web Deployment  
Machine Learning  
System Design and Simulation  
Physical Modeling  
Discrete-Event Simulation  
Rapid Prototyping  
Embedded Code Generation  
HDL Code Generation and Verification  
Verification, Validation, and Test

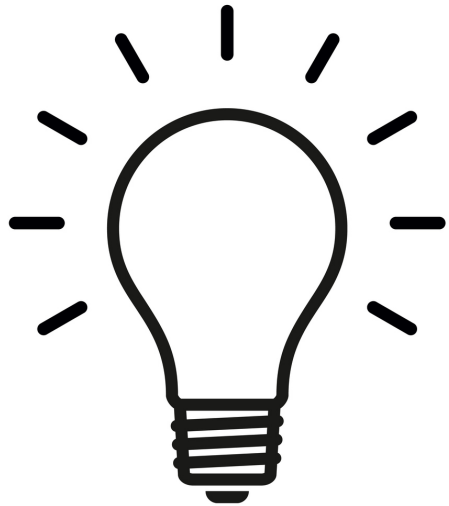
## By Application

Embedded Systems  
Control Systems  
Digital Signal Processing  
Wireless Communications  
Image Processing and Computer Vision  
Internet of Things  
FPGA Design and Codesign  
Mechatronics  
Test and Measurement  
Computational Biology  
Computational Finance  
Robotics  
Data Analytics  
Motor and Power Control  
Deep Learning

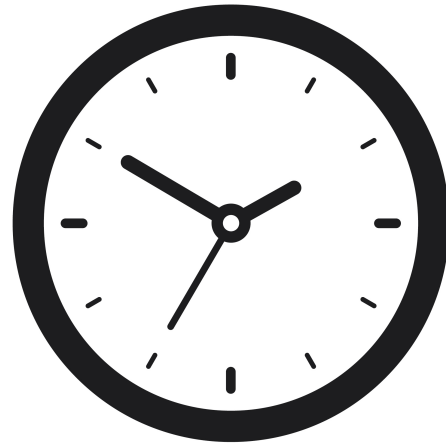
## By Industry

Aerospace and Defense  
Automotive  
Biological Sciences  
Biotech and Pharmaceutical  
Communications  
Electronics  
Earth, Ocean, and Atmospheric Sciences  
Energy Production  
Financial Services  
Industrial Automation and Machinery  
Medical Devices  
Metals, Materials, and Mining  
Neuroscience  
Railway Systems  
Semiconductors  
Software and Internet  
See More Industries

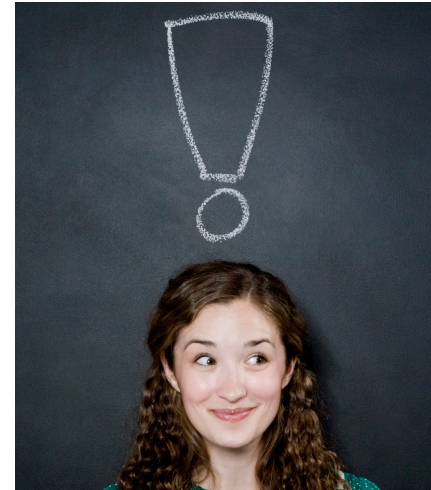
# Benefits of teaching & learning with MATLAB/Simulink



**Get ideas**



**Save time**



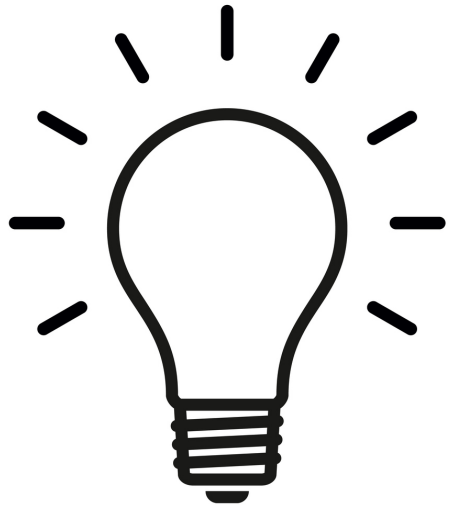
**Engage students**



**Anytime, anywhere**



# Benefits of teaching & learning with MATLAB



**Get ideas**



**Save time**



**Engage students**



**Anytime, anywhere**

# Examples from others teaching with MATLAB


Teaching resources created by your peers:

[www.mathworks.com/academia/courseware.html](http://www.mathworks.com/academia/courseware.html)

## MATLAB Courseware

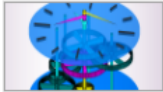
[Educator Home](#) | 
 [Classroom Resources](#) ▾ | 
 [Hardware Support](#) | 
 [License Options](#) ▾ | 
 [Research](#)

### Introduction to Engineering



**Engineering Models I**


*Professor Kathleen Ossman  
Professor Gregory Bucks  
University of Cincinnati*



**Engineering Models II**


*Professor Kathleen Ossman  
Professor Gregory Bucks  
University of Cincinnati*

### Bioengineering and Biological Sciences



**Bioengineering Mass Transport and Systems**


*Professor Alyssa Taylor  
University of Washington*



**Instrumentation, Measurement and Control in Biological Systems**

*Professor Kumar Mallikarjunan  
Virginia Polytechnic Institute & State University*

### Earth, Ocean, and Atmospheric Sciences



**Teaching Geoscience with MATLAB**

*from SERC@Carleton*

### Electrical and Computer Engineering



# MATLAB for teaching and learning in Sciences

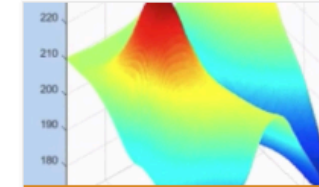
<https://www.mathworks.com/academia/courseware/teaching-science-with-matlab.html>

## Teach and Learn MATLAB



### Teaching Physics with MATLAB

- » Integrate MATLAB into Physics curricula



### Teaching Geoscience with MATLAB

- » Integrate MATLAB into Geoscience curricula



### Teaching Biology with MATLAB

- » Integrate MATLAB into Biology curricula



### Teaching Calculus with MATLAB

- » Integrating MATLAB into Calculus curricula



### Teaching Chemistry with MATLAB

- » Integrate MATLAB into Chemistry curricula



### Teaching Psychology and Neuroscience with MATLAB

- » Integrate MATLAB into Psychology and Neuroscience curricula



### Teaching Econometrics with MATLAB

- » Integrating MATLAB into Econometrics curricula



### Teaching Quantitative Finance and Risk Management with MATLAB

- » Integrating MATLAB into Quantitative Finance and Risk Management curricula



### Computational Thinking with MATLAB

- » Teach quantitative thinking skills in your course

# Ideas from the industry/application/domain: Videos and Webinars

[www.mathworks.com/videos](http://www.mathworks.com/videos)

MathWorks® Products Solutions Academia Support Community Events

Videos and Webinars Search Videos Videos

Videos Home Search Contact sales Trial software

## MATLAB and Simulink Videos

Learn about MATLAB® and Simulink®, watch demonstrations about how to get started, and explore what's new.

Search for videos

— Explore videos by product —

**Applications:** Internet of Things, Robotics, Wireless Communications, Image Processing and Computer Vision, Data Analytics, Power Electronics Control Design

### MATLAB Videos

- Introduction
- Getting Started
- What's New
- Data Analytics and Machine Learning
- Deep Learning
- Image Processing and Computer Vision
- Computational Finance
- Signal Processing and Wireless Communications

#### Introduction

What Is MATLAB?  
Get an overview of MATLAB, the language of technical computing. 2:05

Analyzing and Visualizing Data with MATLAB 3:26

Programming and Developing Algorithms with MATLAB 4:32

Developing and Deploying Applications with MATLAB 3:51

Technical Computing with MATLAB 2:38



# Ideas from the industry: MATLAB Examples

[www.mathworks.com/examples/](http://www.mathworks.com/examples/)

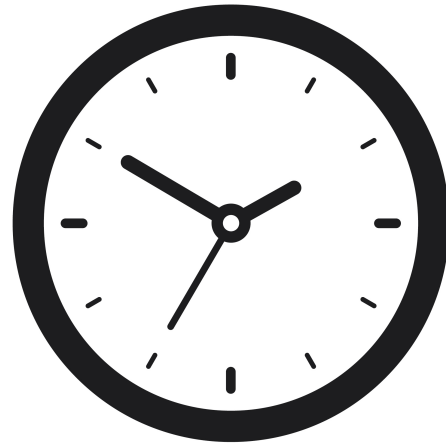
The screenshot shows the MATLAB Examples website interface. At the top, there is a navigation bar with the MathWorks logo and links for Products, Solutions, Academia, Support, Community, and Events. Below this is a search bar labeled "Search Examples" and a dropdown menu for "Examples". A left-hand sidebar lists various categories under "MATLAB Family", "Simulink Family", and "Polyspace Family". The main content area features a carousel of example cards. The first card is titled "Object Detection in a Cluttered Scene Using Point Feature Matching" and includes a thumbnail image of a cluttered scene with a calculator and a small black object. Below the image, it says "Included in: Computer Vision System Toolbox". Below the carousel, a "Most Viewed" section displays four example cards: "Introduction to MIMO Systems" (with a BER plot), "Scatter Plot and Eye Diagram for Quadrature Signal" (with eye diagrams), "CoMP Dynamic Point Selection with Multiple CSI Processes" (with a CoMP diagram), and "Simulating Automatic Climate Control Systems" (with a Simulink block diagram).

<https://www.mathworks.com/examples/#carousel-example-generic>

# Benefits of teaching & learning with MATLAB



**Get ideas**



**Save time**



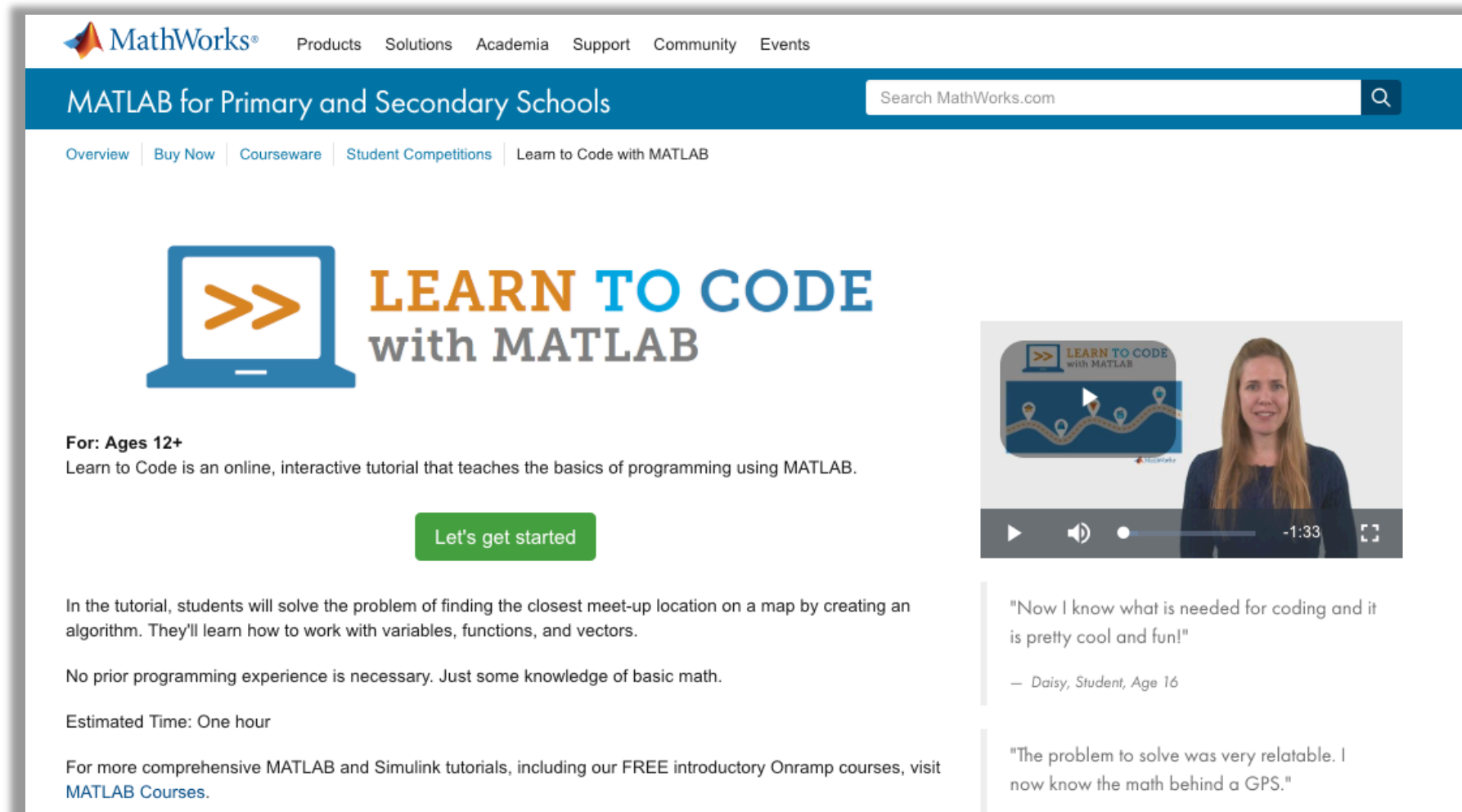
**Engage students**



**Anytime, anywhere**

# Learn to Code with MATLAB

<https://learntocode.mathworks.com/>



The screenshot shows the MathWorks website page for 'Learn to Code with MATLAB' for primary and secondary schools. The page features a navigation bar with links for Products, Solutions, Academia, Support, Community, and Events. A search bar is located in the top right. The main heading is 'MATLAB for Primary and Secondary Schools'. Below this, there are navigation links for Overview, Buy Now, Courseware, Student Competitions, and Learn to Code with MATLAB. The central graphic includes a laptop icon with MATLAB code symbols (>>) and the text 'LEARN TO CODE with MATLAB'. A green button labeled 'Let's get started' is prominently displayed. To the right, there is a video player showing a woman speaking, with a quote from a student below it. The video player controls show a play button, volume, progress bar, and a timestamp of -1:33.

**For: Ages 12+**  
Learn to Code is an online, interactive tutorial that teaches the basics of programming using MATLAB.

[Let's get started](#)

In the tutorial, students will solve the problem of finding the closest meet-up location on a map by creating an algorithm. They'll learn how to work with variables, functions, and vectors.

No prior programming experience is necessary. Just some knowledge of basic math.

Estimated Time: One hour

For more comprehensive MATLAB and Simulink tutorials, including our FREE introductory Onramp courses, visit [MATLAB Courses](#).

"Now I know what is needed for coding and it is pretty cool and fun!"  
— Daisy, Student, Age 16


"The problem to solve was very relatable. I now know the math behind a GPS."



# Self-paced Online Tutorials

Ideal for introductory assignments or a refresher:

<https://matlabacademy.mathworks.com/>




FREE

## MATLAB Onramp

Get started quickly with the basics of MATLAB.

---

[Launch](#)
[Details](#)



NEW


FREE

## Simulink Onramp

Get started quickly with the basics of Simulink.

---

[Details](#)



FREE

## Deep Learning Onramp

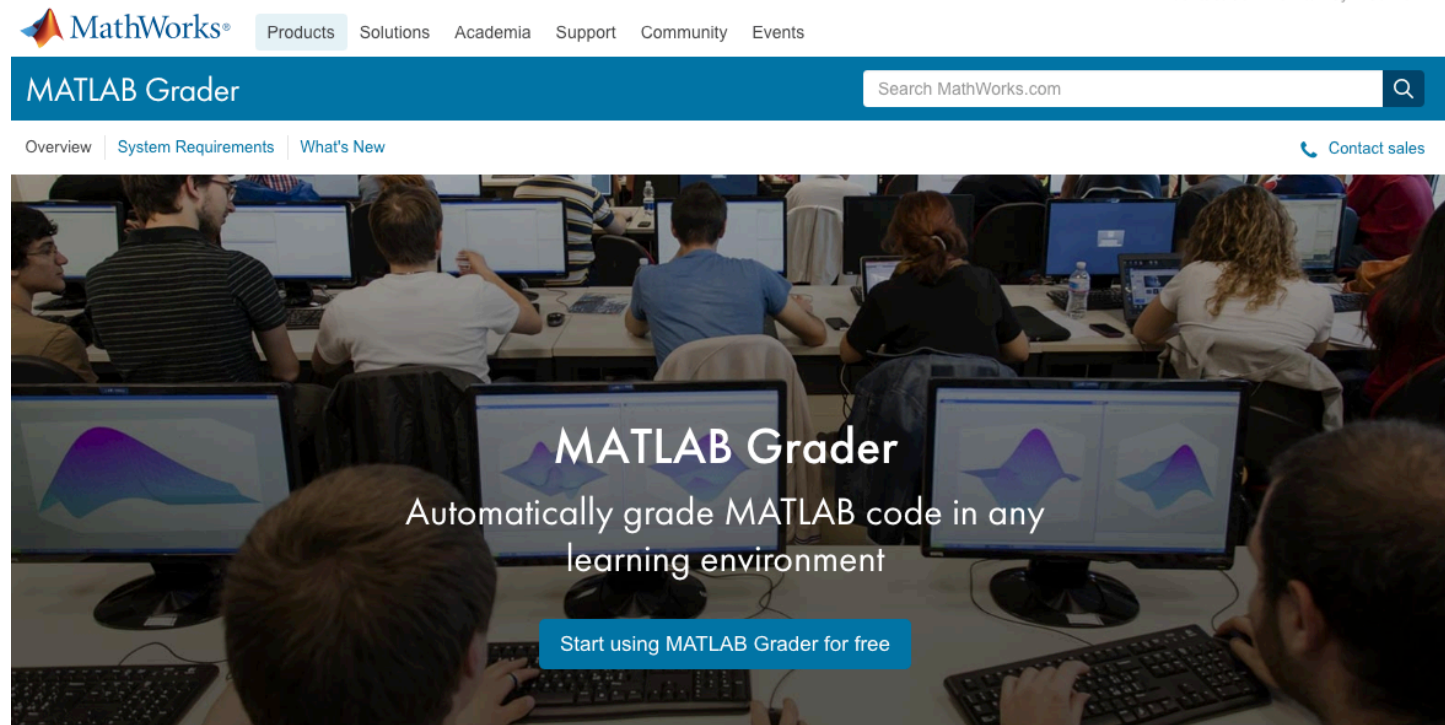
Get started quickly using deep learning methods to perform image recognition.

---

[Launch](#)
[Details](#)

# Automatically grade code (MATLAB Grader)

Instant Feedback and Analytics: <https://grader.mathworks.com/>



Create interactive course assignments



Automatically grade student work and provide feedback



Run your assignments in any learning environment

# Educators and Instructors are Teaching with MATLAB Grader

Student Solutions

Search by student name, solution ID, or function

View: All Solutions Test Solutions Submitted Solutions

Size

Order of arrival

Incorrect Correct Leading

MATLAB Grader automates grading of assignments at Technische Universiteit Eindhoven

[» Learn more](#)

**1,000+** instructors

Year	Courses using MATLAB
Year 1	ENGE 1114
Year 2	AOE 2074, AOE 2104
Year 3	AOE 3034, AOE 3054, AOE 3134
Year 4	AOE 4065-66, AOE 4134, AOE 4404

Students' computational problem-solving proficiency

ENGE 1114 = Exploration of Engineering Design  
 AOE 2074 = Computational Methods  
 AOE 2104 = Introduction to Aerospace Engineering  
 AOE 3034 = Vehicle Vibration and Control  
 AOE 3054 = Experimental Methods

AOE 3134 = Stability and Control  
 AOE 4065-66 = Aircraft Design  
 AOE 4134 = Astronautics  
 AOE 4404 = Applied Numerical Methods

MATLAB Grader enhances student learning at Virginia Tech

[» Learn more](#)

**100,000+** students

“The fact that you can get immediate feedback (or confirmation) on a quite complicated piece of code is really neat, and without it, debugging your own code would really be a mess. It also motivated me to get 100% score on all the MATLAB assignments.”

— Jooost P., Virginia Tech Student

**Over 6 million** student submissions



# External Interfaces

## Calling Libraries Written in Another Language From MATLAB



- Java
- Python **R2014b**
- C/C++
- Fortran
- COM components and ActiveX<sup>®</sup> controls
- RESTful, HTTP, and WSDL web services

## Calling MATLAB from Another Language



- Java **R2016b**
- Python **R2014b**
- C/C++
  - Updated C++ API **R2017b**
- Fortran
- COM Automation server

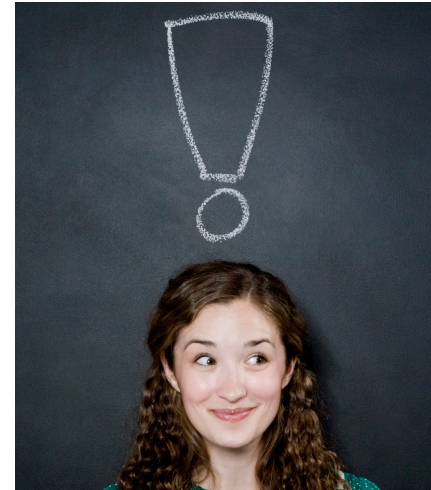
# Benefits of teaching & learning with MATLAB



Get ideas



Save time



**Engage students**

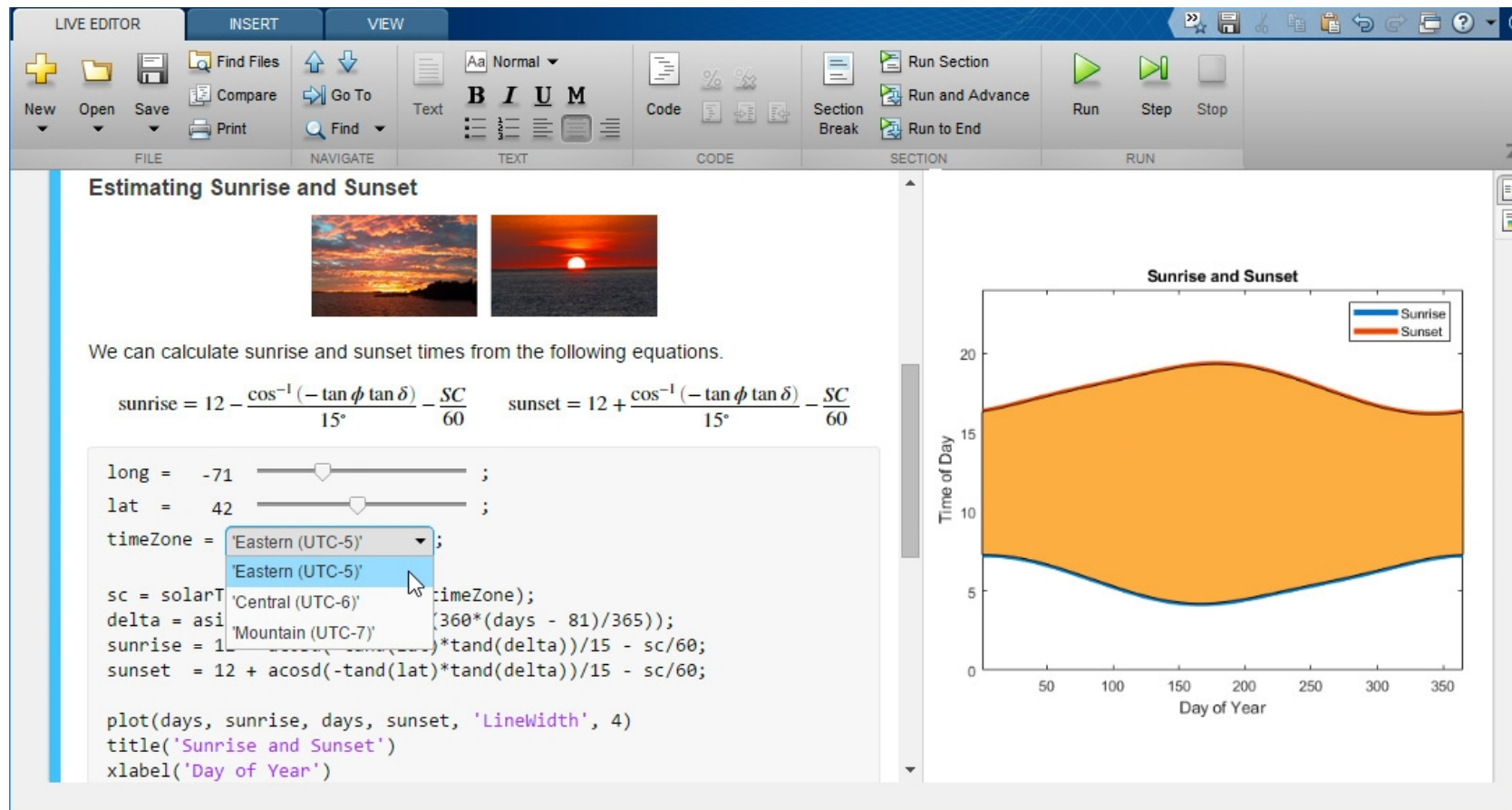


Anytime, anywhere

# Interactive MATLAB documents – Live Editor

Single environment for content and code:

[www.mathworks.com/products/matlab/live-editor.html](http://www.mathworks.com/products/matlab/live-editor.html)



The screenshot shows the MATLAB Live Editor interface. The document is titled "Estimating Sunrise and Sunset" and contains two images of a sunset. Below the images, the text reads: "We can calculate sunrise and sunset times from the following equations."

$$\text{sunrise} = 12 - \frac{\cos^{-1}(-\tan \phi \tan \delta) - SC}{15^\circ} - \frac{SC}{60} \quad \text{sunset} = 12 + \frac{\cos^{-1}(-\tan \phi \tan \delta) - SC}{15^\circ} - \frac{SC}{60}$$

The code editor shows the following MATLAB code:

```

long = -71;
lat = 42;
timeZone = 'Eastern (UTC-5)';
sc = solarTime(lat, long, timeZone);
delta = asin(sin(sc) * cos(lat));
sunrise = 12 - (acosd(-tand(lat)*tand(delta))/15 - sc)/60;
sunset = 12 + (acosd(-tand(lat)*tand(delta))/15 - sc)/60;

plot(days, sunrise, days, sunset, 'LineWidth', 4)
title('Sunrise and Sunset')
xlabel('Day of Year')
    
```

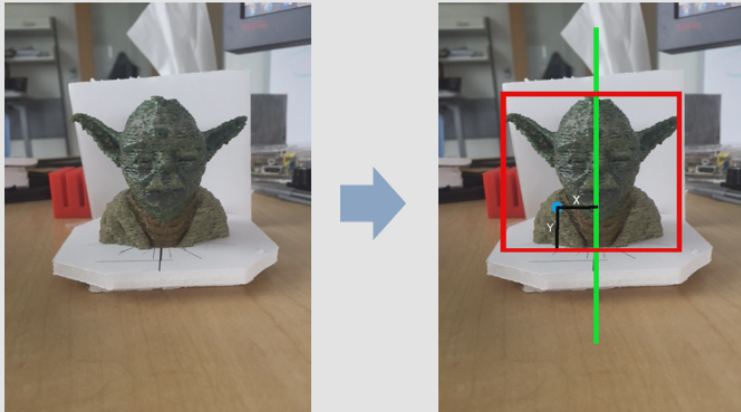
The plot, titled "Sunrise and Sunset", shows the "Time of Day" (Y-axis, 0 to 20) versus the "Day of Year" (X-axis, 0 to 350). The plot displays two curves: "Sunrise" (blue line) and "Sunset" (orange line). The area between the two curves is shaded orange. The sunrise time starts at approximately 7:30 AM in January, reaches a minimum of about 4:30 AM in June, and returns to 7:30 AM in December. The sunset time starts at approximately 5:30 PM in January, reaches a maximum of about 8:30 PM in June, and returns to 5:30 PM in December.



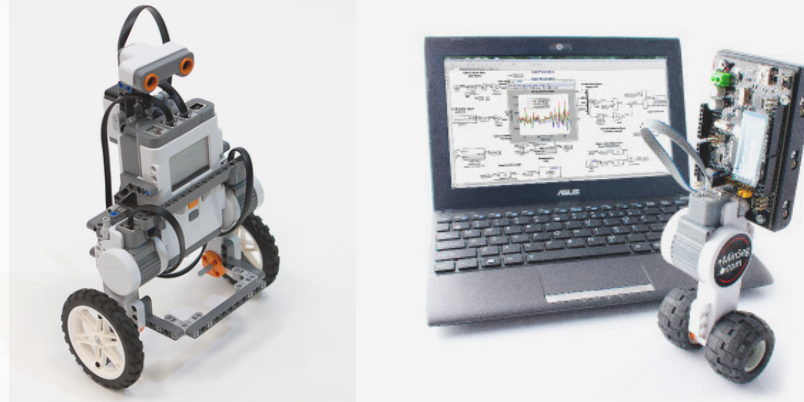
# Hands-on with Project-Based Learning

Low-cost Hardware and Mobile Sensors:

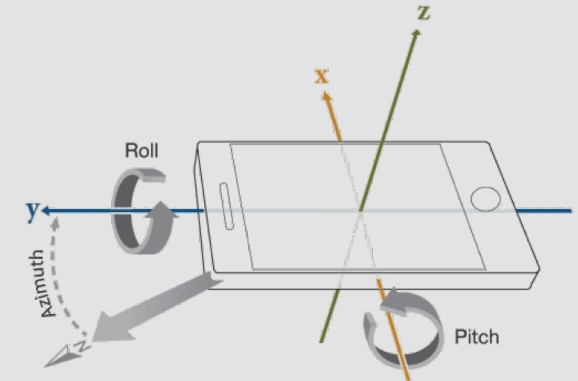
[www.mathworks.com/hardware-support](http://www.mathworks.com/hardware-support)



MATLAB based 3D Scanner using  
Raspberry Pi



Self-balancing robots using  
LEGO and Arduino

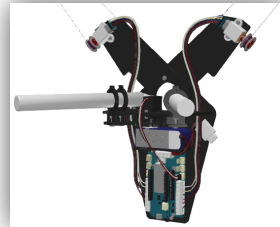
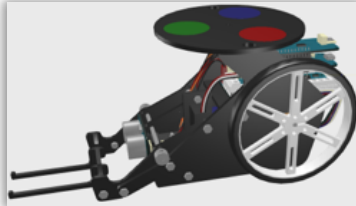
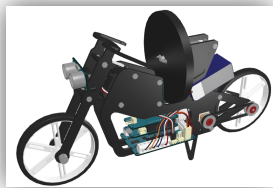


Sensor support for  
Android and iOS devices

Search: MATLAB Hardware Catalog

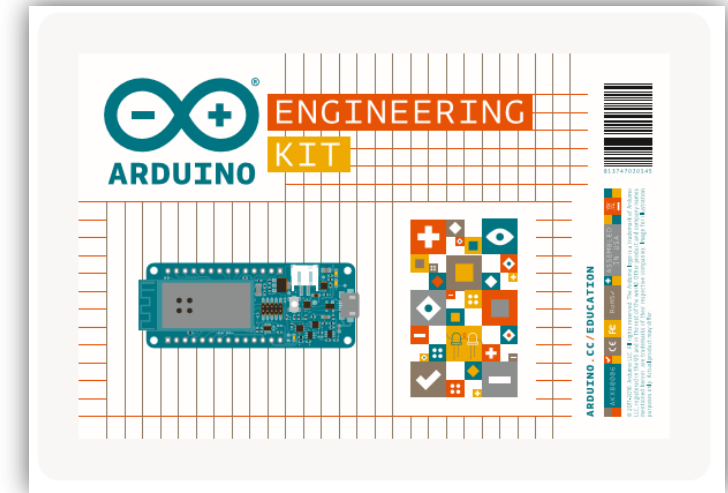
# Arduino Engineering Kit - Inside the Box

- Arduino MKR1000 board and all components to create 3 engaging, hands-on projects:



- 1-year individual user license of MATLAB and Simulink products
- Online learning materials that facilitate projects

**Available through the Arduino Store**

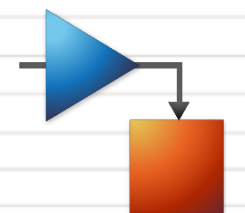
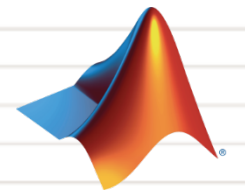


## THIS KIT CONTAINS:

- 1 Arduino MKR1000 Board
- 1 Arduino MKR Motor Shield
- 1 Arduino MKR IMU Shield
- 1 DC Motor
- 2 Geared DC Motors with Encoders
- 1 Standard Micro Servo
- 1 Hall Sensor Module
- 1 Ultrasonic Sensor Module
- 1 Webcam
- 1 LiPo Battery
- 1 Lipo Battery Charger
- 1 Micro USB Cable
- 1 3to4 Pin Module Cable
- 1 3pin Module Cable
- 3 Sets of Assembly Pieces

- 2 Wheels
- 1 Caster Wheel
- 1 Timing Belt
- 2 Timing Pulleys
- 2 DC Motor Mounting Brackets
- 1 Metal Shaft (90 mm)
- 2 Metal D Shafts(50 mm)
- 1 Set of Distance Spacers (17 mm)
- 1 Sets of M2 Bolts (10 mm, 25mm)
- 1 Sets of M3 Bolts (10 mm, 15 mm, 25 mm)
- 1 Set of M3 Locknuts with Nylon Insert
- 3 Shaft Collars
- 1 Propeller Adapter Screw

- 2 Magnets
- 1 Thread
- 2 Whiteboard Pens
- 1 Sticker for Image Recognition



# Learning Guides for Getting Started

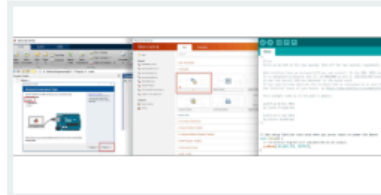
## ARDUINO ENGINEERING KIT

You will be introduced to engineering through a series of practical exercises, resources and theoretical material to easily learn fundamental concepts and key aspects of mechatronics and programming. For it, you will be using Arduino, MATLAB® and Simulink®. The content of this course is divided into six chapters and it has been designed to be followed sequentially from chapters 1 to 3, which should be used as reference when needed. Chapters 4, 5 and 6 are projects, they can be done at any order, but it is recommended to start with chapter 4.



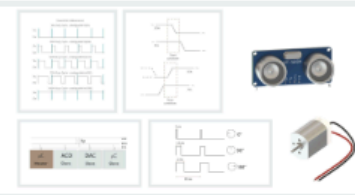
### 1. INTRODUCTION

Get started with the Arduino Engineering course, get to know the materials included in the kit and the tools you will use to build the projects.



### 2. GETTING STARTED

Learn the basics for Arduino IDE, MATLAB® user interface, and Simulink® models. You will discover how these three tools can be connected to each other while making practical exercises.



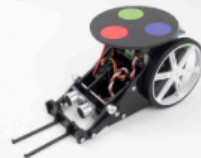
### 3. CONCEPTS

Go through a detailed explanation about key engineering concepts such as encoders, I2C communication, PWM signals, and LiPo batteries.



### 4. DRAWING ROBOT

Build a robot that extracts line traces from an image and program it to reproduce and duplicate the image as a drawing on a whiteboard. You will learn about physics, programming, and robotics.



### 5. MOBILE ROVER

Build and program a mobile rover to follow paths, move objects with a forklift, and avoid obstacles. You will learn about differential drive robots and how to simulate their behavior, control their position or speed, and perform localization.



### 6. SELF-BALANCING MOTORCYCLE

Build and program a motorcycle that self balances and maneuvers by itself on different terrains using a flywheel. You will learn about physics, control algorithms, and how to simulate the vehicle's overall behavior.

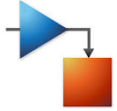
Introduces engineering fundamentals with:

- Kit instructions
- Key theoretical concepts & background
- Practical exercises

<https://create.arduino.cc/edu/courses/>

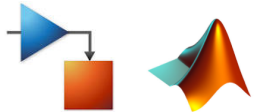


# Projects



- **Self-balancing motorcycle**

- Maneuvers itself on varying terrain and remains upright using a flywheel for balance
- Concepts: Controls, IMU sensing, filter design, system modeling, simulation



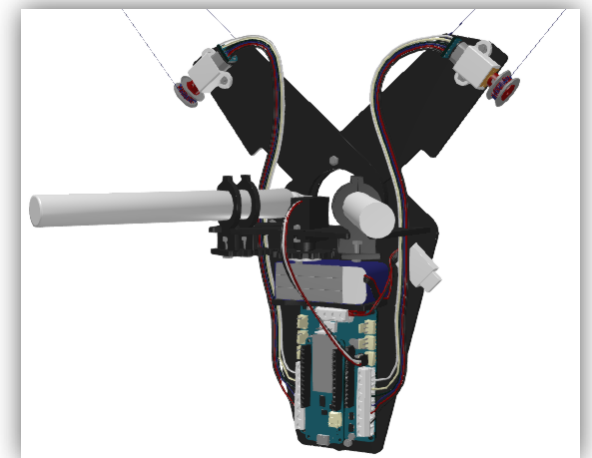
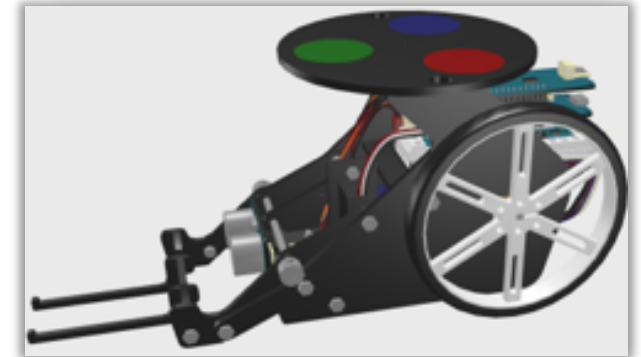
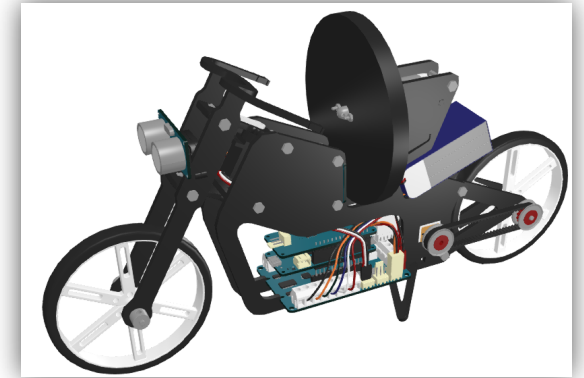
- **Mobile rover**

- Navigates between reference points, locates and moves objects with a forklift
- Concepts: Robotics, system modeling, simulation, controls, object tracking, localization



- **Drawing robot**

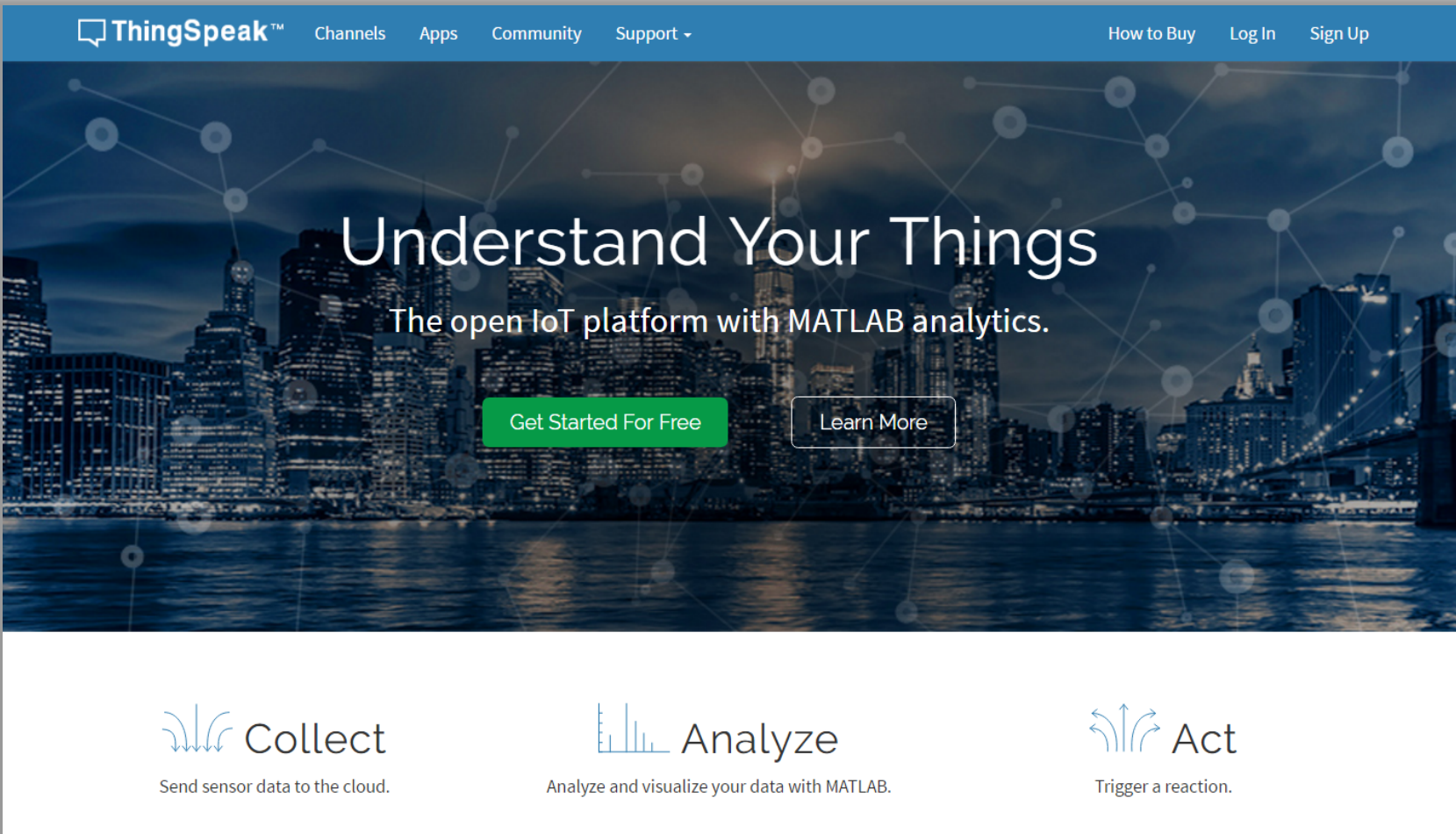
- Takes a reference drawing and duplicates it on a whiteboard
- Concepts: Image acquisition & processing, optimization, kinematics



# Internet of Things (IoT) with ThingSpeak

Cloud-based projects / workflows:

[www.mathworks.com/products/thingspeak.html](http://www.mathworks.com/products/thingspeak.html)



The screenshot shows the ThingSpeak website homepage. The top navigation bar includes the ThingSpeak logo, links for Channels, Apps, Community, and Support, and options for How to Buy, Log In, and Sign Up. The main content area features a city skyline at night with a network overlay. The headline reads "Understand Your Things" with the subtext "The open IoT platform with MATLAB analytics." Below this are two buttons: "Get Started For Free" and "Learn More". The bottom section is divided into three columns: "Collect" (Send sensor data to the cloud.), "Analyze" (Analyze and visualize your data with MATLAB.), and "Act" (Trigger a reaction.).

ThingSpeak™ Channels Apps Community Support ▾ How to Buy Log In Sign Up

## Understand Your Things

The open IoT platform with MATLAB analytics.

Get Started For Free Learn More

**Collect**  
Send sensor data to the cloud.

**Analyze**  
Analyze and visualize your data with MATLAB.

**Act**  
Trigger a reaction.

# Benefits of teaching & learning with MATLAB



Get ideas



Save time



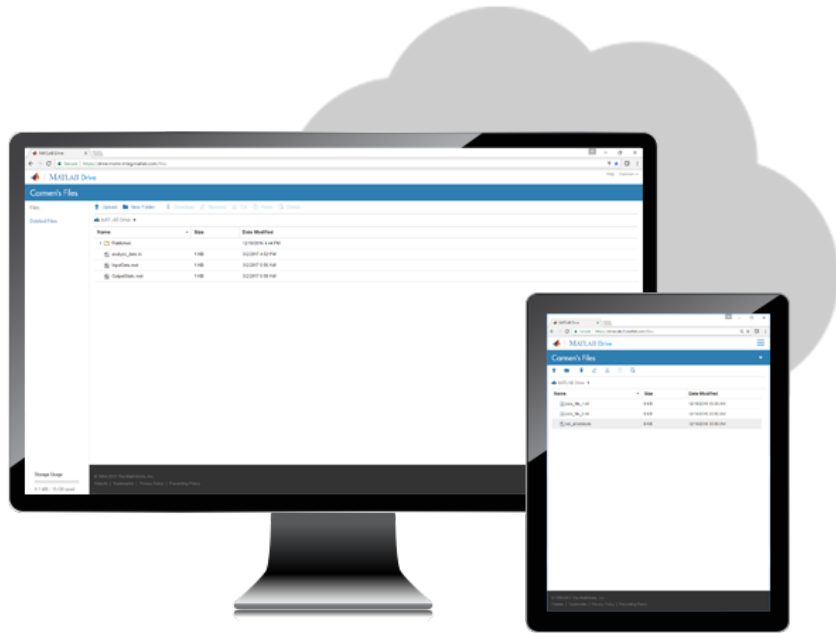
Engage students



**Anytime, anywhere**

# Convenient, lightweight access directly through the web: [www.mathworks.com/products/matlab-online.html](http://www.mathworks.com/products/matlab-online.html)

## MATLAB Online



No download or installation required  
 Always running the latest version



Synchronize across all devices



# Everything is mobile now ... even MATLAB:

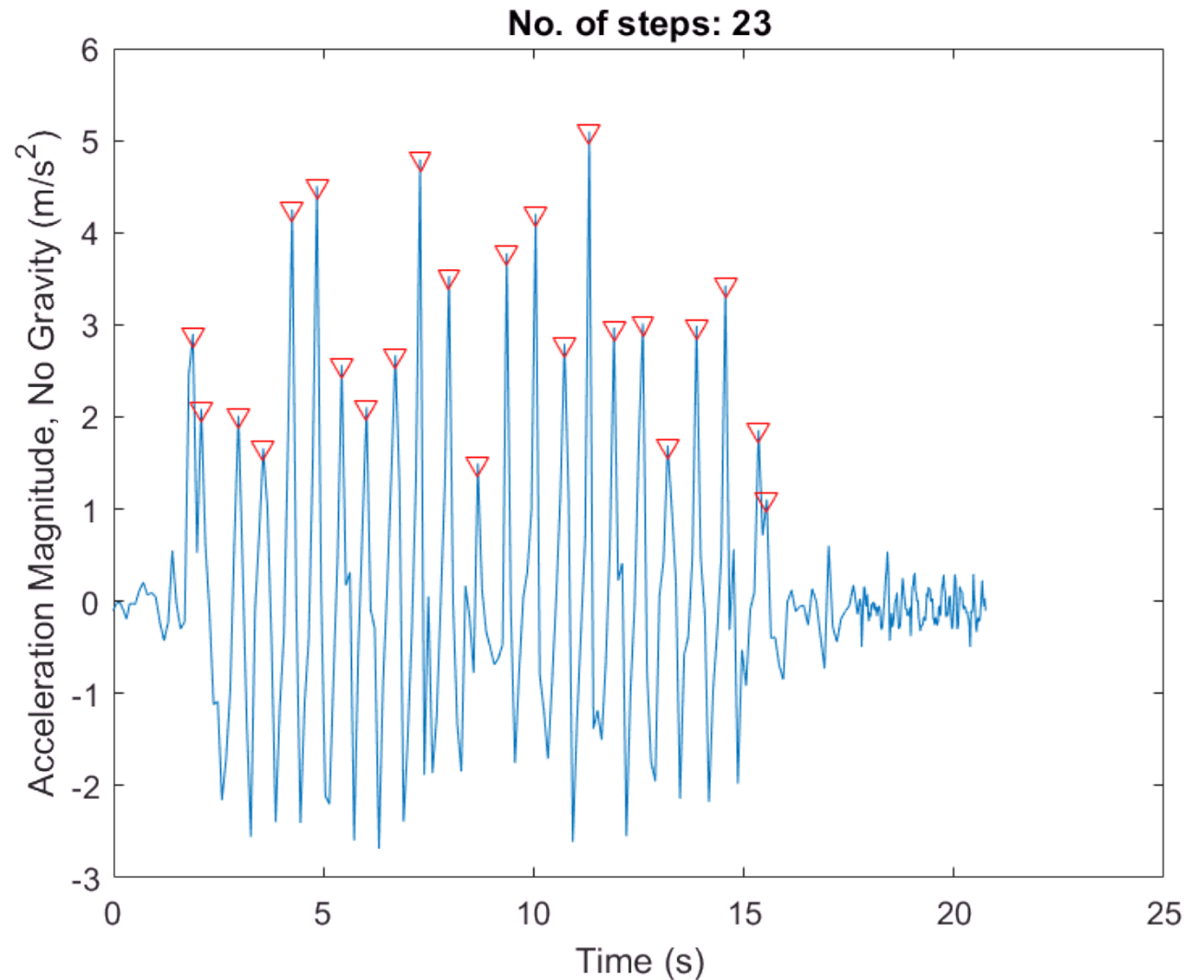
[www.mathworks.com/products/matlab-mobile.html](http://www.mathworks.com/products/matlab-mobile.html)

Sensors

Acceleration

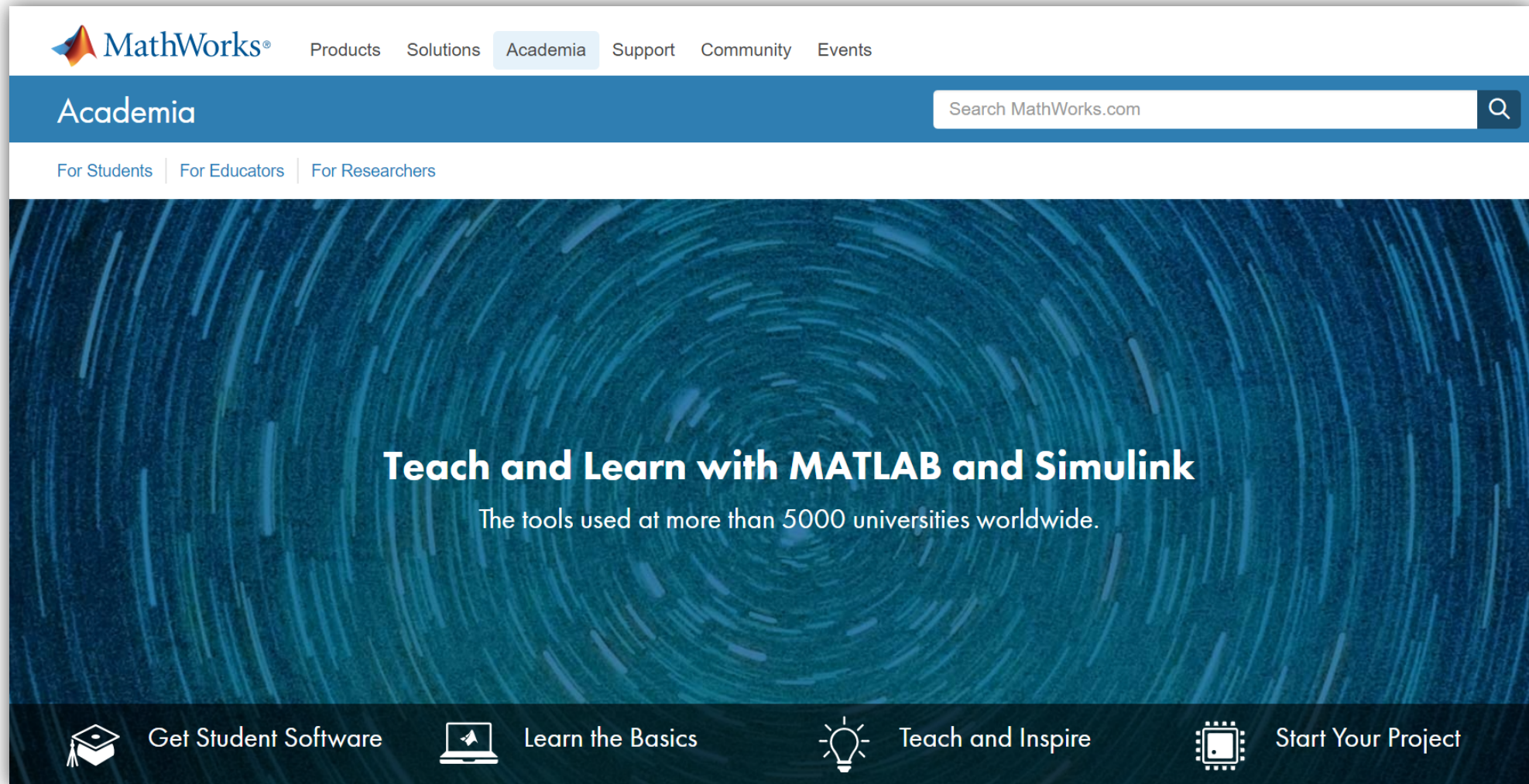
X <small>m/s<sup>2</sup></small>	-0.073
Y <small>m/s<sup>2</sup></small>	0.071
Z <small>m/s<sup>2</sup></small>	10.147
<span>Orientation</span>	
Azimuth <small>degrees</small>	61.306
Pitch <small>degrees</small>	0.596
Roll <small>degrees</small>	-1.930

Start Sending



# Resources for Educators and Students

[mathworks.com/academia](https://mathworks.com/academia)



The screenshot shows the MathWorks Academia website. At the top, the MathWorks logo is on the left, and navigation links for Products, Solutions, Academia (highlighted), Support, Community, and Events are on the right. Below this is a blue header with the word "Academia" on the left and a search bar on the right containing the text "Search MathWorks.com". Underneath the header, there are three links: "For Students", "For Educators", and "For Researchers". The main content area has a dark blue background with a circular pattern of light blue lines. In the center, the text reads "Teach and Learn with MATLAB and Simulink" in white, with a subtitle below it: "The tools used at more than 5000 universities worldwide." At the bottom, there is a dark blue footer with four icons and their corresponding text: a graduation cap icon for "Get Student Software", a laptop icon for "Learn the Basics", a lightbulb icon for "Teach and Inspire", and a microchip icon for "Start Your Project".

## What if I need help?

- Explore product pages and documentation
- Leverage the MATLAB user community
- Contact
  - Technical Support
  - Customer Success Engineer
  - Account Manager

# Q & A