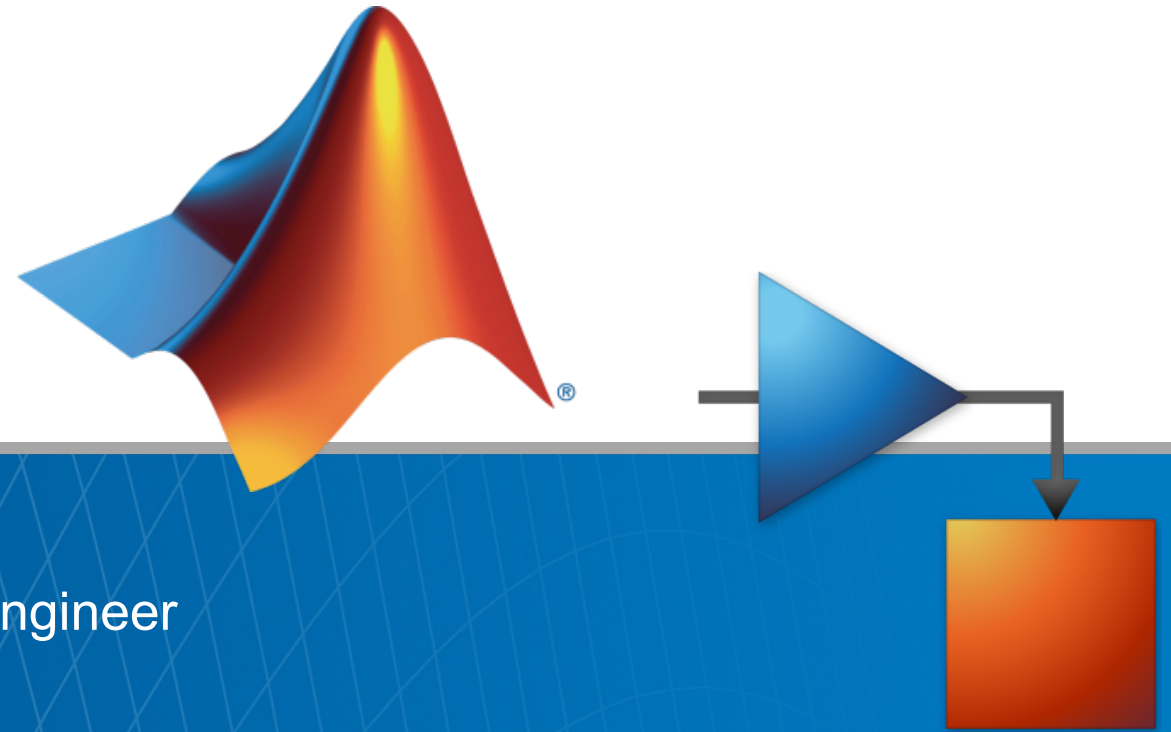


Virtual Labs with MATLAB & Simulink

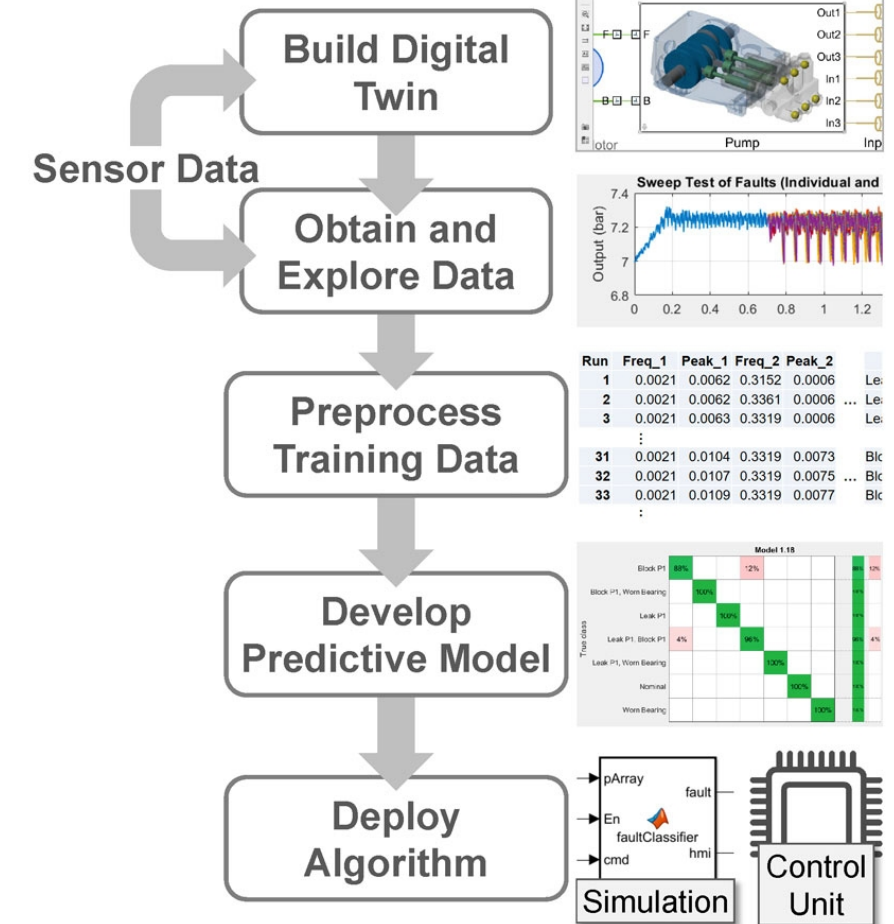
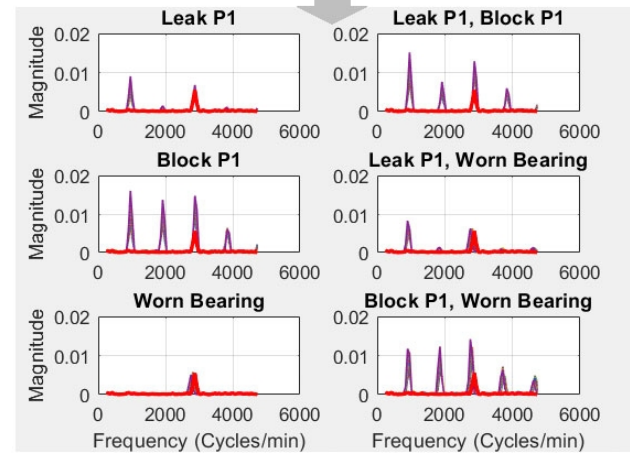
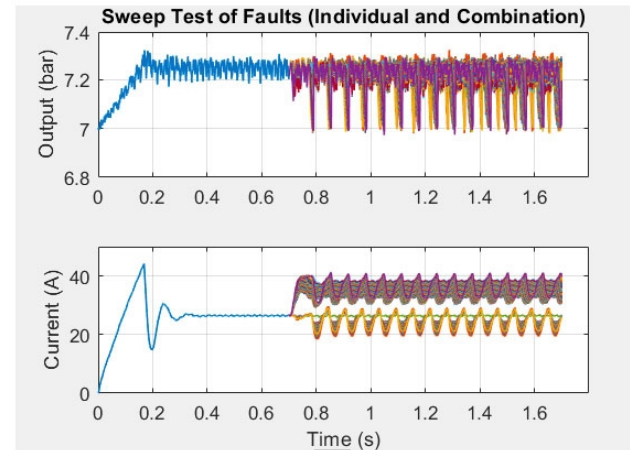
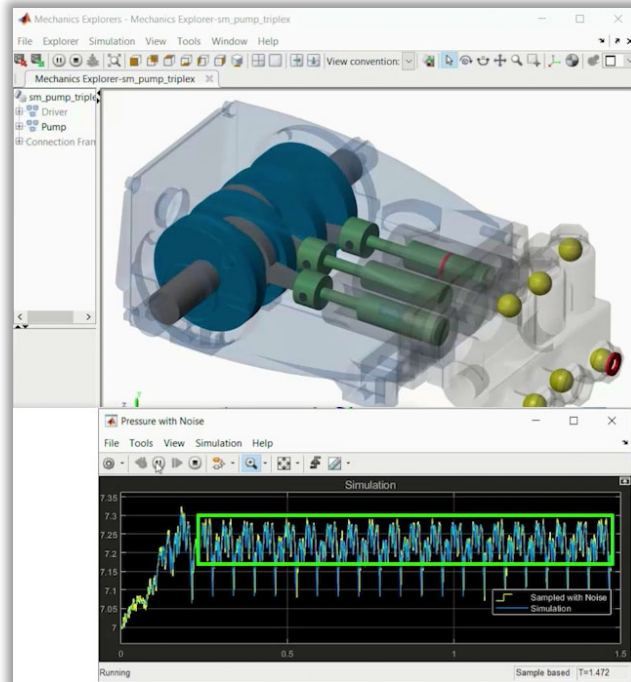


Sumit Tandon – Senior Customer Success Engineer

Digital Transformation



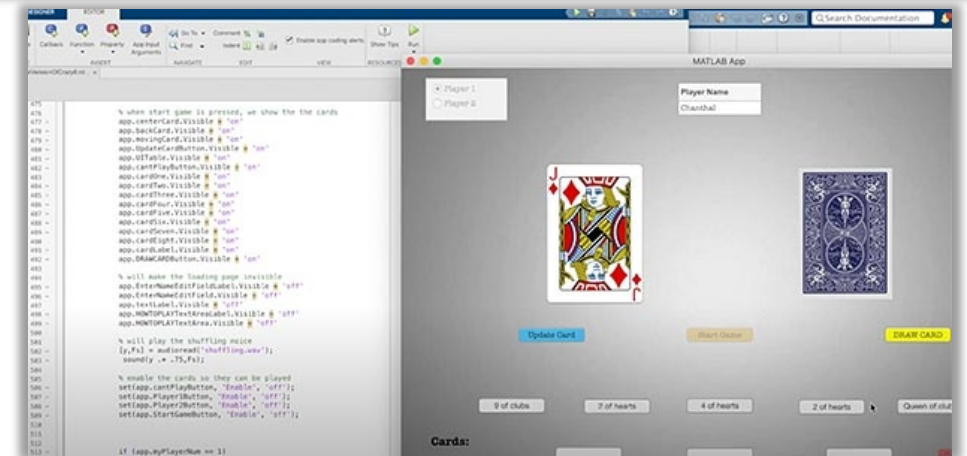
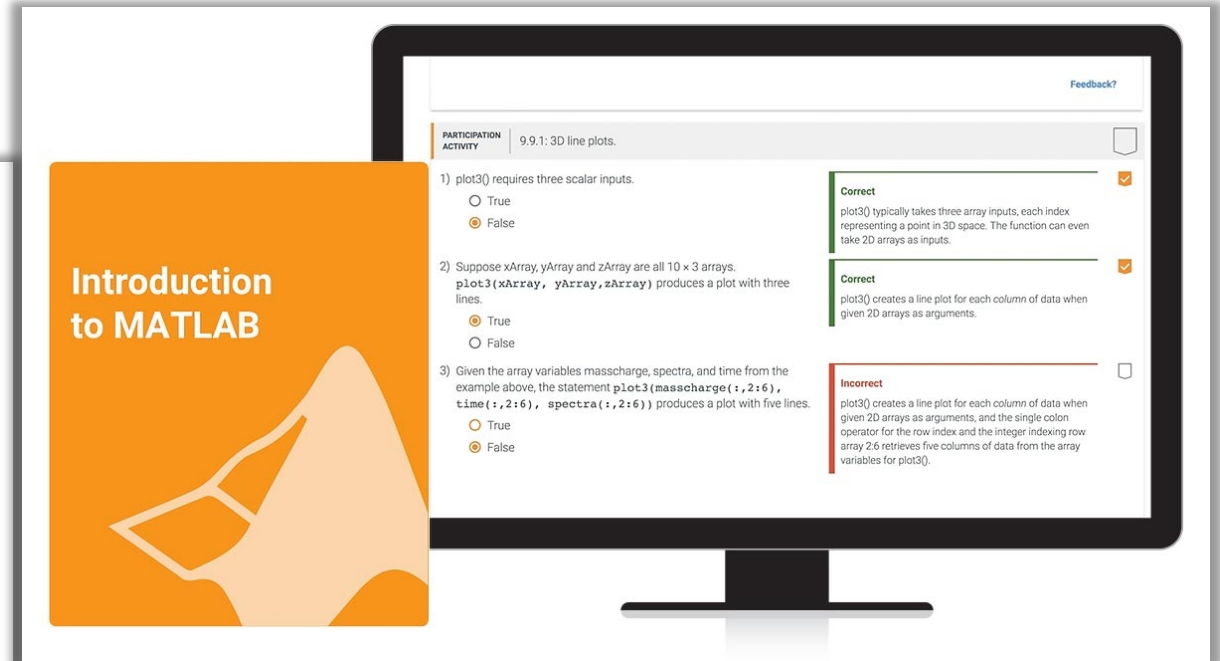
Digital Transformation in Industry & Academia



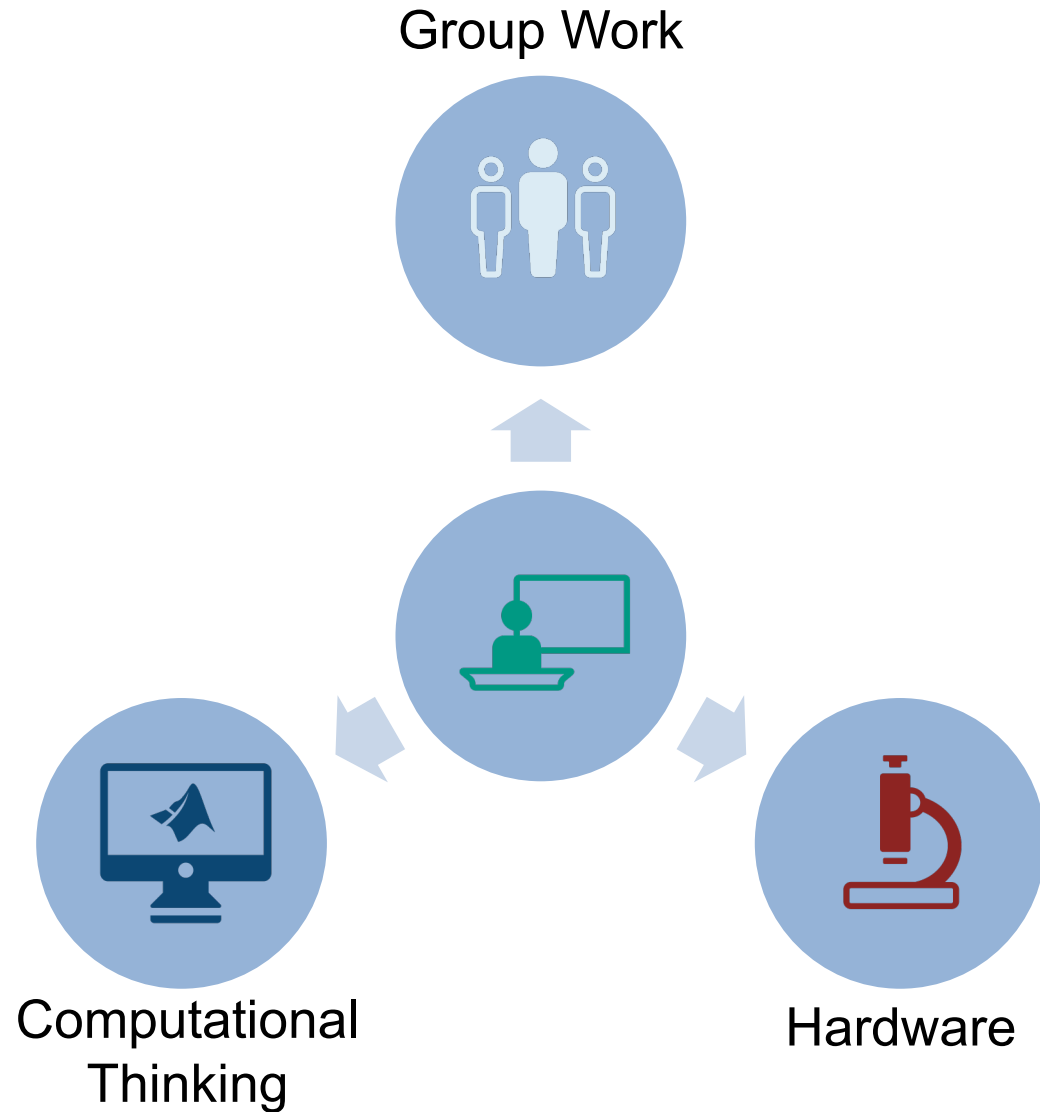
Digital Transformation in Industry & Academia



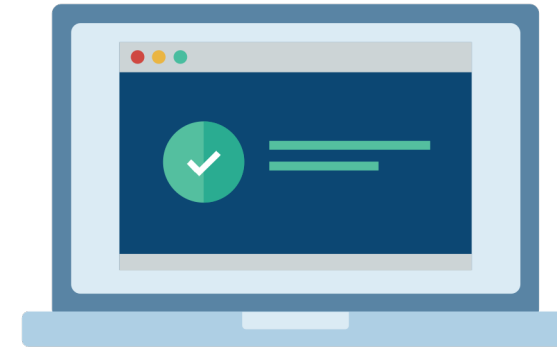
www.mathworks.com/company/mathworks-stories/uc-davis-matlab-remote-learning.html



Incorporate lessons learned for the future.



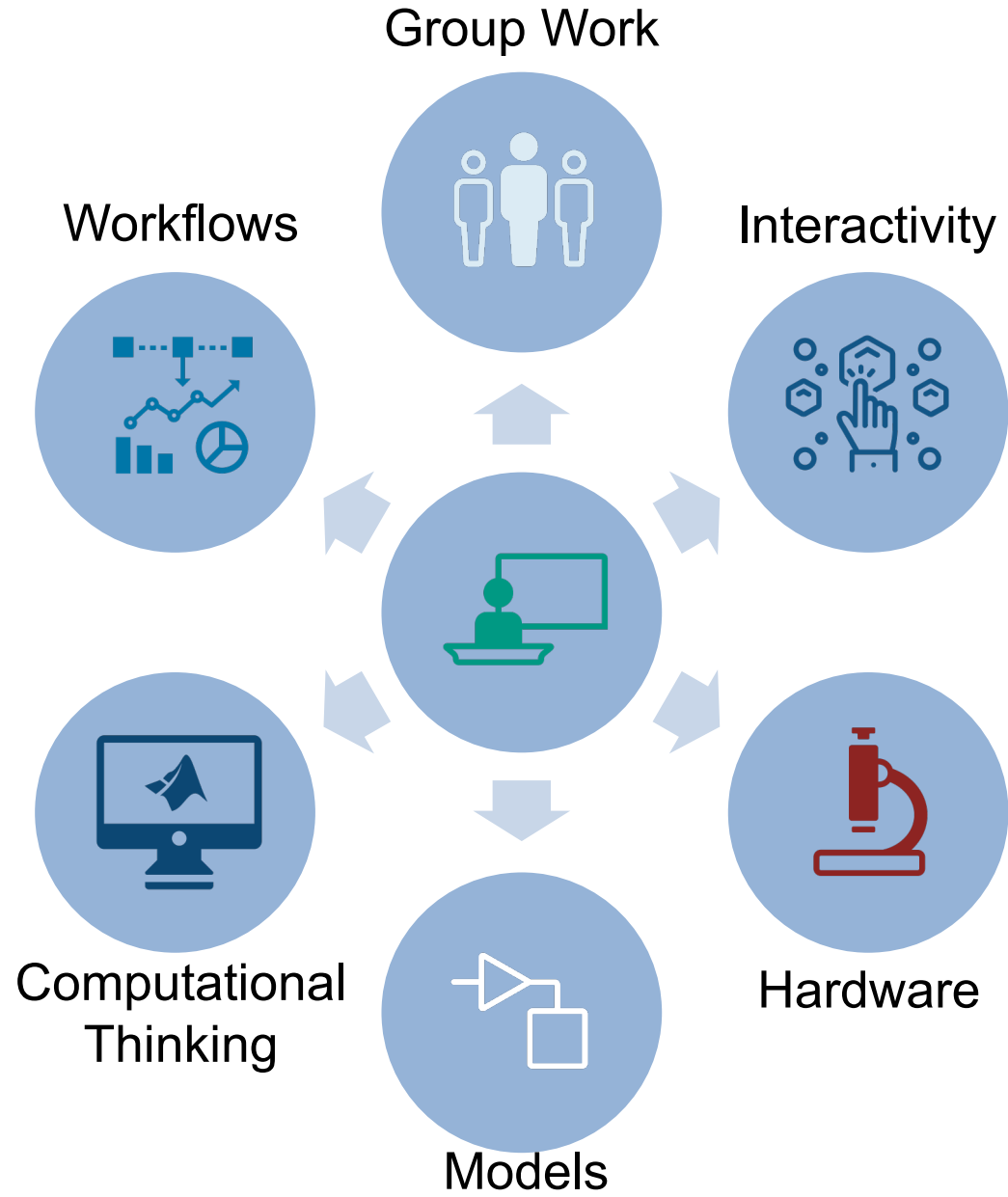
Short Term



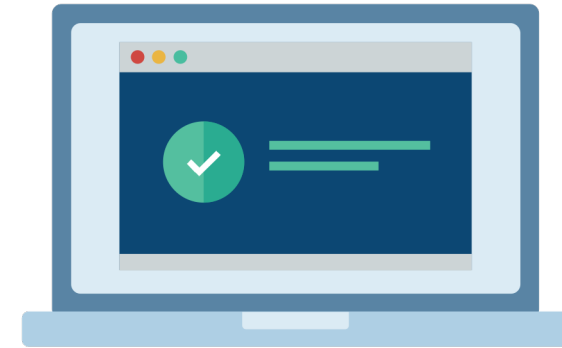
Long Term



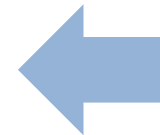
Incorporate lessons learned for the future.



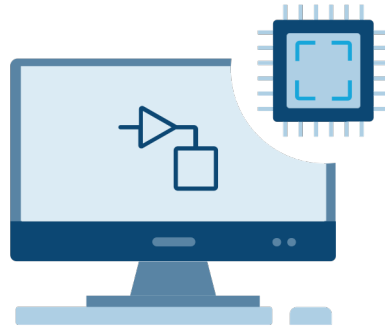
Short Term



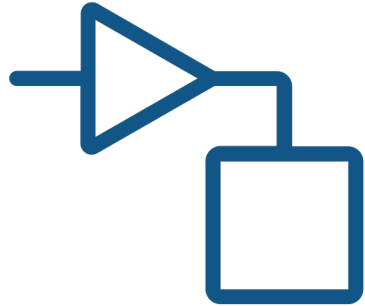
Long Term



Typical Lab Workflow

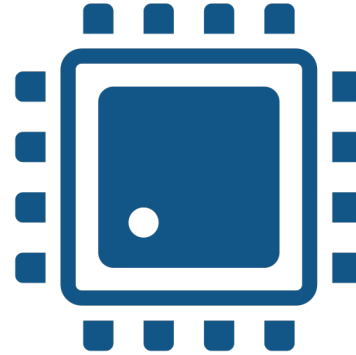


Laboratory Models



Virtual

Virtual Labs exist in the virtual space to simulate a process, test, apparatus, or other activity.



Hardware at Home

Hardware Labs incorporates kits, mobile devices, or other components that exist at home or off campus.



Remote

Remote Labs use equipment that exists on campus but is viewed, accessed, or even controlled by students remotely.

Realism

Cost

Logistics

Industrial tools

Objective

Complexity

Collaboration

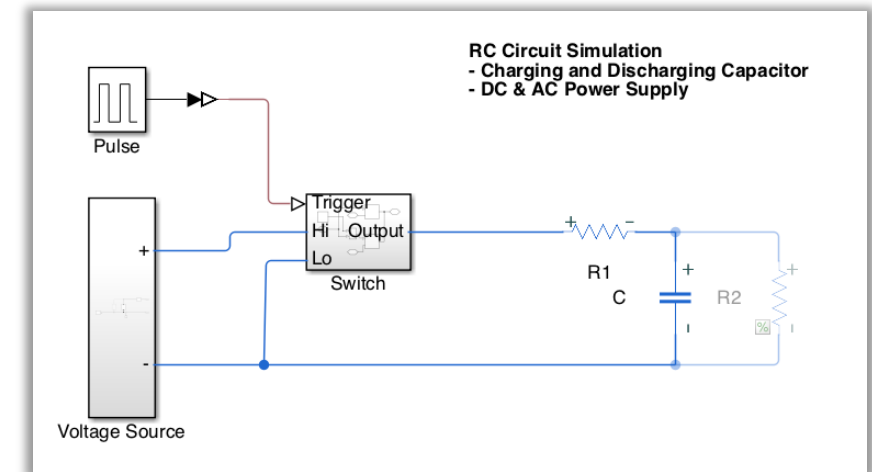
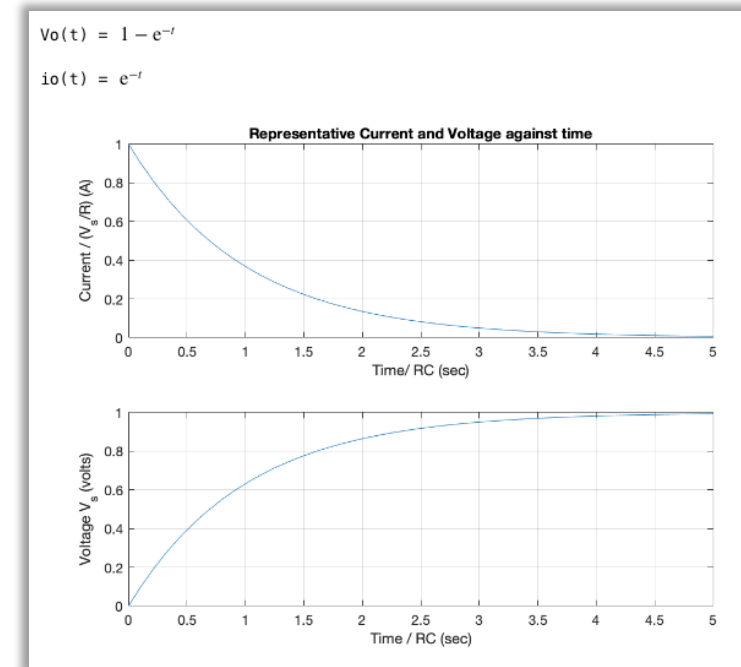
Experience

Industrial workflows

Approach 1: Virtual Lab

Example: RC Circuit

- Goal:
 - Introduce RC Circuits and reinforce concepts via labs
- Approach:
 - Introduce the concept
 - Derive and explore the mathematical representation of RC Circuits
 - Explore in 'virtual lab' using Simulink
 - Assign problems to explore further
 - Create a project report



Demo 1 highlights

- Introduce a new concept
- Explore it mathematically
- Perform virtual experiments
- Extend exploration to advanced concepts
- Capture everything in a report

Products used:

- MATLAB
- Symbolic Math Toolbox
- Simulink
- Simscape
- Simscape Electrical



Approach 2: Hardware-at-home

Example: Deep Learning with a Smartphone

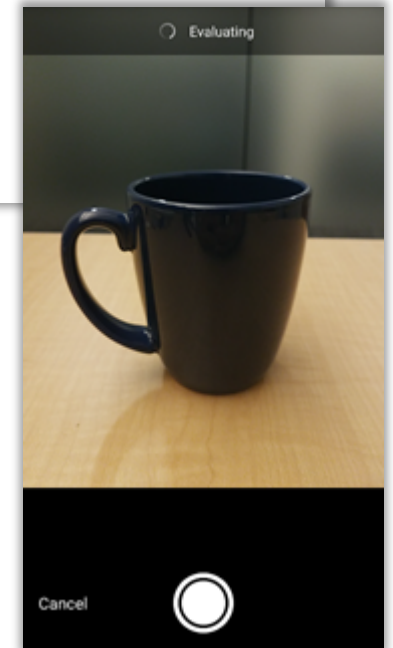
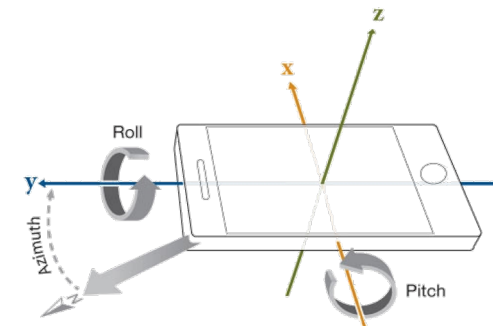
- **Goal:**
 - Introduce students to Deep Learning
- **Approach:**
 - Introduce theory in the class
 - Set up iOS mobile device to use MATLAB Mobile
 - Access pre-trained GoogLeNet network
 - Use mobile device camera to set up Deep Learning exploration experiment

Write a Function to Classify an Image

You can write a function in MATLAB Mobile that performs all the previous steps to classify images.

On the Files screen, create a new script in your MATLAB Drive™ folder. Name the file `camnet.m`. Define the `camnet` function as follows and save the file.

```
function value = camnet(cam,nnet)
    img = snapshot(cam,'manual');
    pic = imresize(img,[224,224]);
    value = classify(nnet,pic);
    image(pic)
    title(char(value))
end
```



Demo 2 highlights

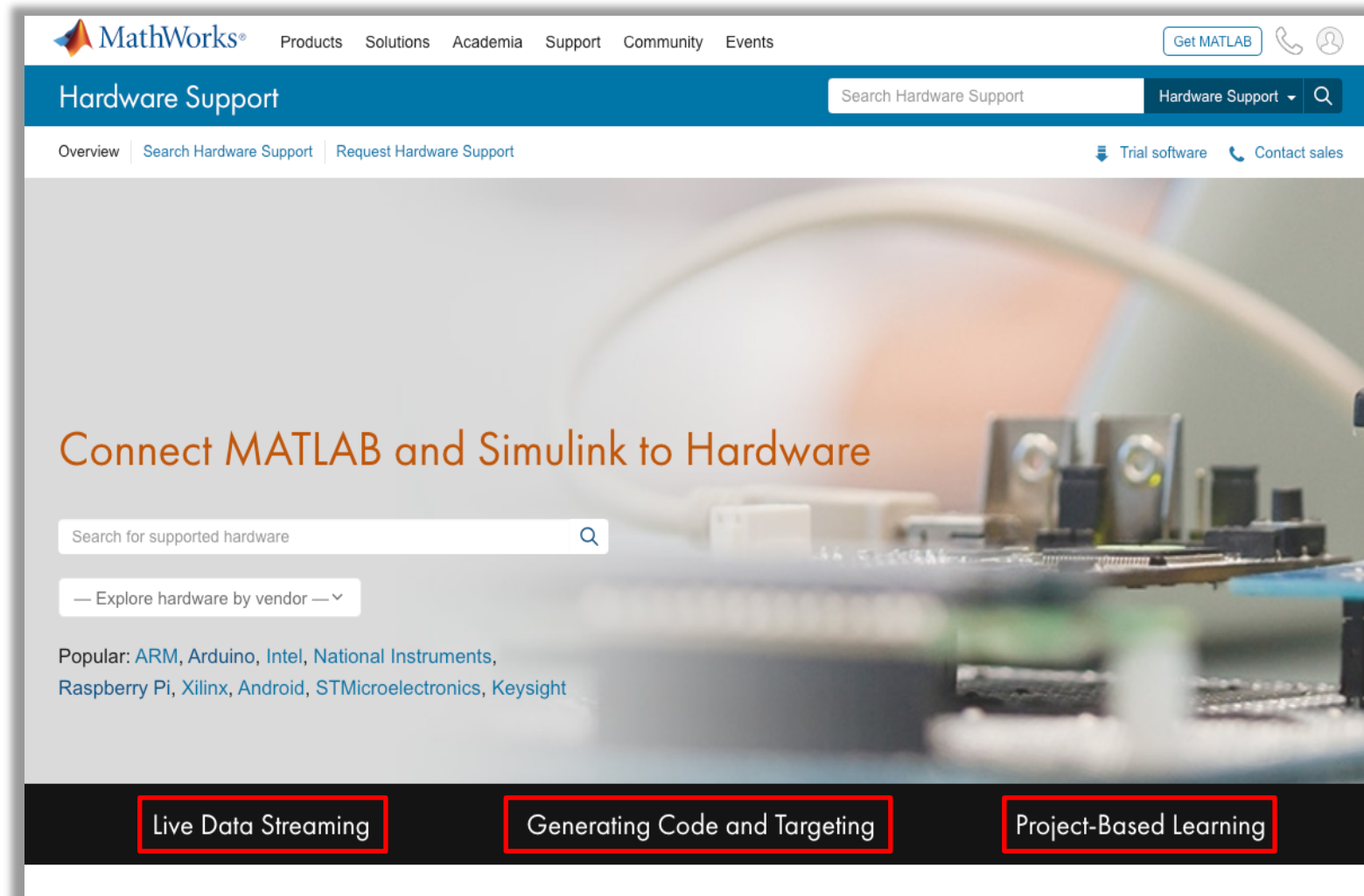
- Use readily accessible hardware
- Explore & experiment with advanced concepts with ease

Products used:

- MATLAB
- MATLAB Mobile
- Deep Learning Toolbox



www.mathworks.com/hardware



The screenshot shows the MathWorks Hardware Support page. At the top is the MathWorks logo and a navigation bar with links for Products, Solutions, Academia, Support, Community, and Events. A 'Get MATLAB' button and user icons are on the right. Below this is a blue header for 'Hardware Support' with a search bar and a dropdown menu. A secondary navigation bar includes 'Overview', 'Search Hardware Support', and 'Request Hardware Support', along with links for 'Trial software' and 'Contact sales'. The main content area features a background image of a circuit board and the heading 'Connect MATLAB and Simulink to Hardware'. It includes a search bar for supported hardware, a vendor exploration dropdown, and a list of popular vendors: ARM, Arduino, Intel, National Instruments, Raspberry Pi, Xilinx, Android, STMicroelectronics, and Keysight. At the bottom, three red-outlined buttons are displayed: 'Live Data Streaming', 'Generating Code and Targeting', and 'Project-Based Learning'.

MathWorks® Products Solutions Academia Support Community Events

Get MATLAB

Hardware Support

Search Hardware Support Hardware Support

Overview Search Hardware Support Request Hardware Support

Trial software Contact sales

Connect MATLAB and Simulink to Hardware

Search for supported hardware

— Explore hardware by vendor —

Popular: ARM, Arduino, Intel, National Instruments, Raspberry Pi, Xilinx, Android, STMicroelectronics, Keysight

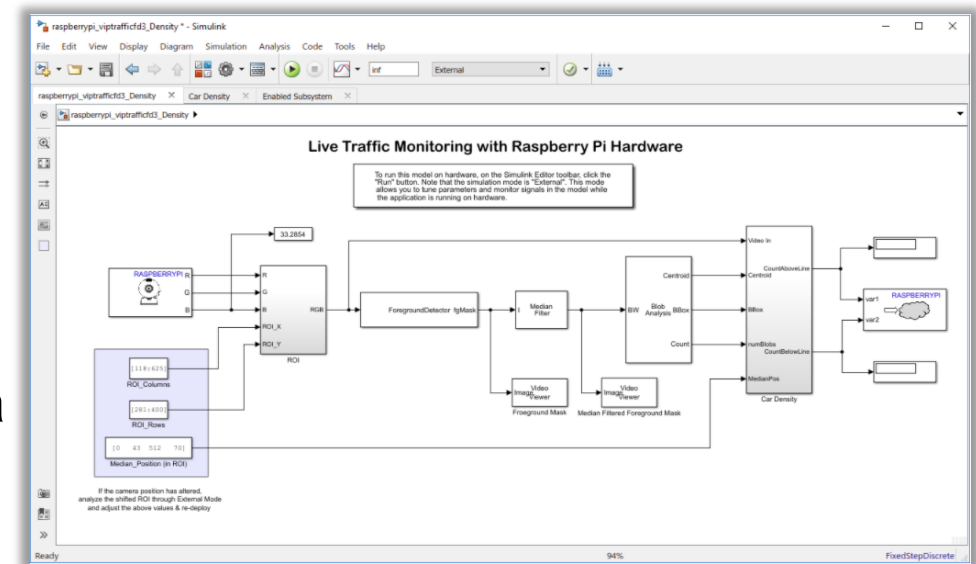
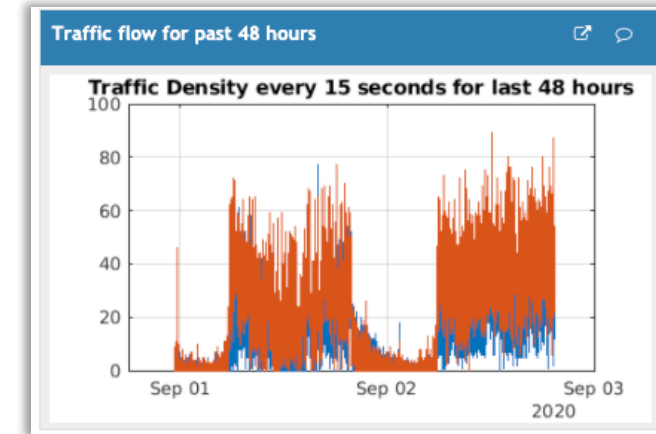
Live Data Streaming Generating Code and Targeting Project-Based Learning

Approach 3: Remotely-Accessed Hardware

Example: Traffic Monitoring and Analysis

- **Goal:**
 - Provide recommendation for traffic/lane management based on remotely collected traffic data

- **Approach:**
 - Acquire data generated by remote hardware and stored on an IoT platform
 - Analyze data locally
 - Share recommendations for wide consumption via IoT
 - Create a report



Demo 3 highlights

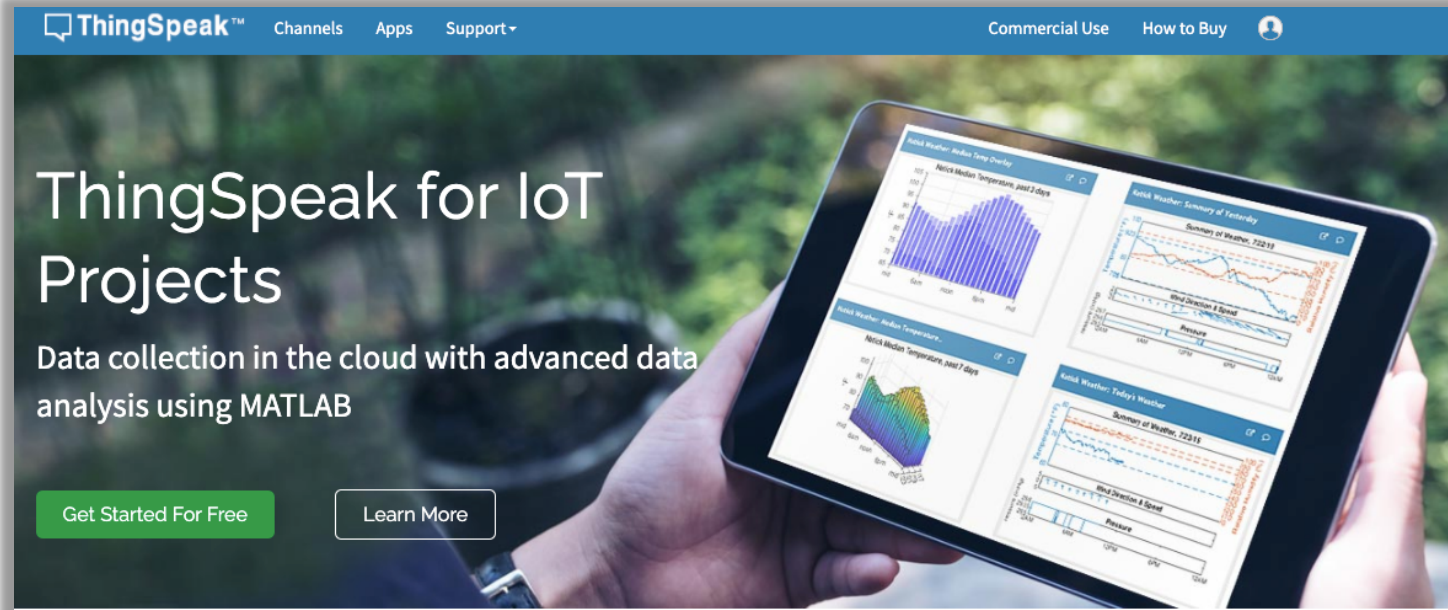
- Acquire data generated by remote hardware
- Analyze data locally
- Use IoT for collaboration

Products used:

- MATLAB
- Statistics & Machine Learning Toolbox
- ThingSpeak



thingspeak.com

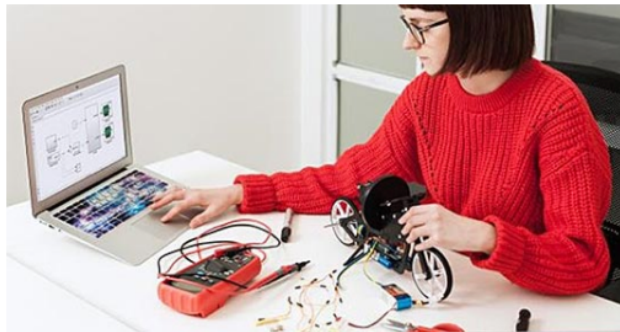


ThingSpeak™ Channels Apps Support Commercial Use How to Buy

ThingSpeak for IoT Projects

Data collection in the cloud with advanced data analysis using MATLAB

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ThingSpeak for Students and Educators

Implement IoT research projects quickly with built-in MATLAB data analysis tools and real-time sensor data collection

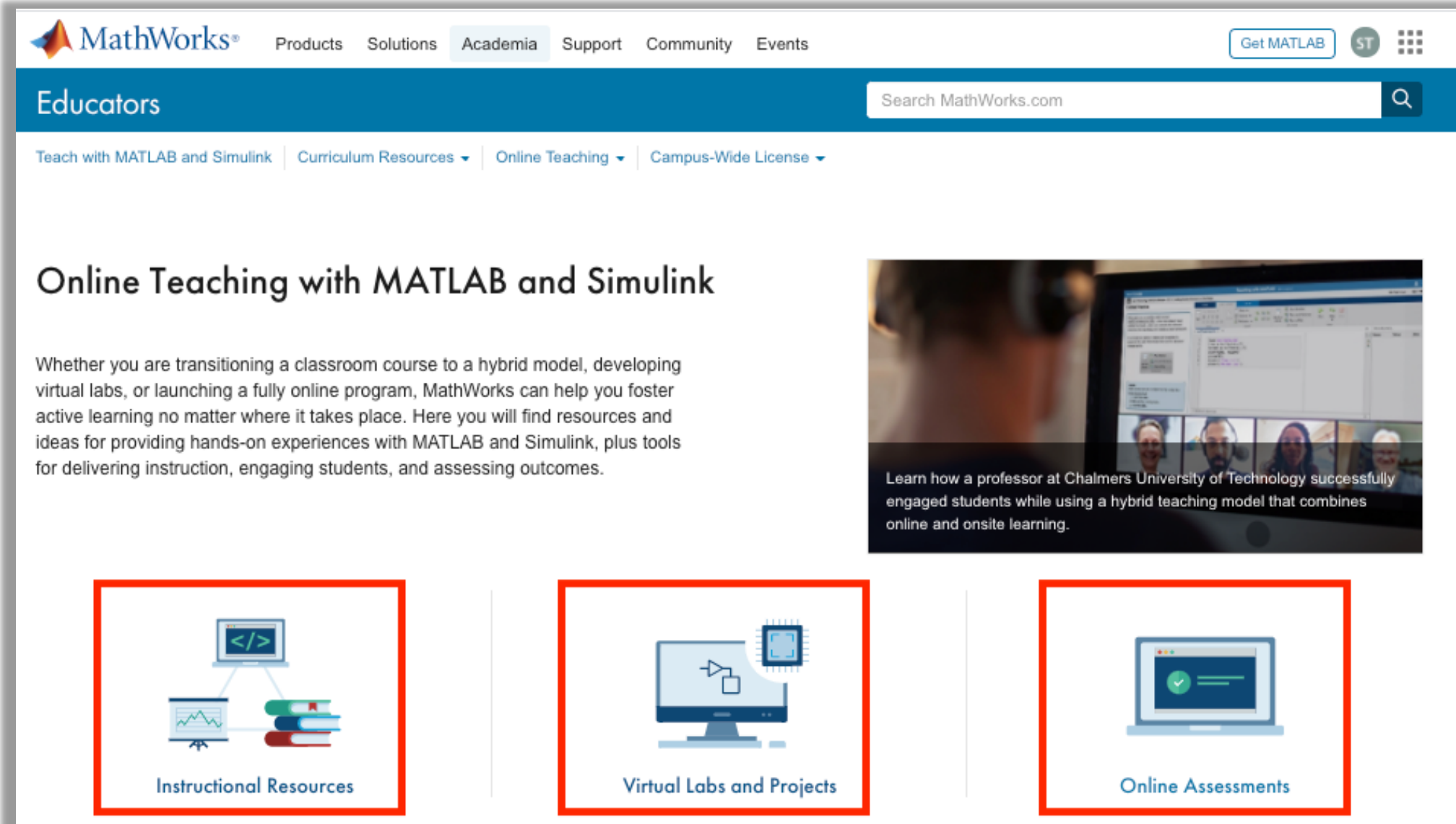


ThingSpeak for Air Quality Monitoring

Build IoT services for remote monitoring of air quality sensors, and create MATLAB models to predict pollution levels

How do I get started?

www.mathworks.com/academia/online-teaching.html



The screenshot shows the MathWorks Academics Online Teaching page. The top navigation bar includes links for Products, Solutions, Academics, Support, Community, and Events. A search bar is located on the right. Below the navigation bar, the page is titled "Educators" and features a search bar. The main content area is titled "Online Teaching with MATLAB and Simulink" and includes a paragraph about transitioning to hybrid or fully online programs. To the right of the text is a video thumbnail showing a professor and students in a hybrid teaching model. Below the text and video are three red-bordered boxes, each containing an icon and a label: "Instructional Resources" (with a laptop and books icon), "Virtual Labs and Projects" (with a monitor and circuit icon), and "Online Assessments" (with a laptop and checkmark icon).

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Teach with MATLAB and Simulink Curriculum Resources Online Teaching Campus-Wide License


Online Teaching with MATLAB and Simulink

Whether you are transitioning a classroom course to a hybrid model, developing virtual labs, or launching a fully online program, MathWorks can help you foster active learning no matter where it takes place. Here you will find resources and ideas for providing hands-on experiences with MATLAB and Simulink, plus tools for delivering instruction, engaging students, and assessing outcomes.


Learn how a professor at Chalmers University of Technology successfully engaged students while using a hybrid teaching model that combines online and onsite learning.

 Instructional Resources

 Virtual Labs and Projects

 Online Assessments

www.mathworks.com/matlabcentral/topics/distance-learning.html

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Online Teaching with MATLAB and Simulink


Whether you are transitioning a classroom course to a hybrid model, developing virtual labs, or launching a fully online program, MathWorks can help you foster active learning no matter where it takes place.


» Learn more

Discussions

Start a discussion

 **Discrete vectors plotting problem**
Latest activity by Jeff Alderson on 23 Oct 2020 at 16:44
Tags: plotting vector unit graph, distance_learning
1
reply

 **Live Script to help student understand concepts**
Latest activity by jiro on 14 Oct 2020 at 14:50
Tags: live script, interactive text, distance_learning
0
replies



Welcome to the Distance Learning Community

Moderator:
Jiro Doke

This is a world-wide community for educators who are teaching remotely or online using MathWorks tools. It houses resources, such as articles, code examples, and videos, as well as an area where community members can ask questions or hold discussions around best practices in distance learning.

Follow the community

Share Tweet Share

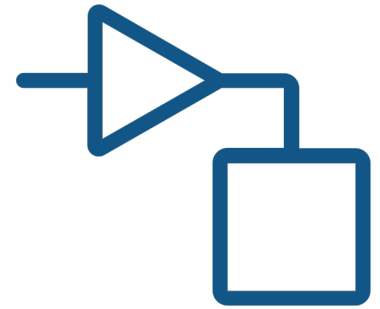
Key takeaways

- Choose one or a combination of online lab approaches that work best for you
 - Virtual
 - Hardware-at-home
 - Remotely accessed hardware
- Explore the MATLAB & Simulink based resources that could help
- Share your thoughts with us at the [Distance Learning Community](#)

Q&A



Approach 1: Virtual RC Circuit Lab



Virtual

Experiment 1: Effect of changing parameters

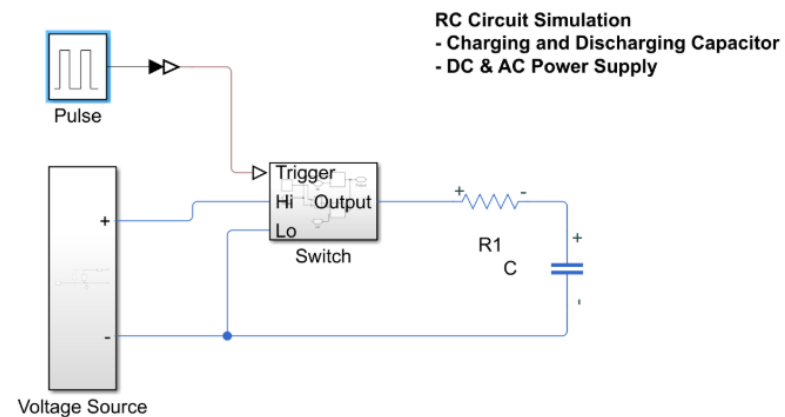
As you see we have the following two equations describing the behaviour of the system. We first create a MATLAB function from the symbolic expressions of voltage and current

```
Vc = matlabFunction(V)
Ic = matlabFunction(i)
```

Set controls to modify resistance, capacitance and input voltage

```
Rc = 451 ; % Ohms
Cc = 0.0007 ; % Farads
Vsc = 10 ;
tc = 0:0.01:1;
figure;
subplot(211); plot(tc,Vc(tc,Cc, Rc, Vsc)); grid on; xlabel('Time (sec)'); ylabel('Voltage (Volts)')
title('Voltage and Current Characteristics');
subplot(212); plot(tc,Ic(tc,Cc, Rc, Vsc)); grid on; xlabel('Time (sec)'); ylabel('Current (Amp)')
```

Experiment 2: Basic RC - Charging and Discharging



1. Load & Run the Simulink Model
2. From the plots experimentally estimate the "Time Constant" of the Charging and Discharging

$$V_o(t) = 1 - e^{-t}$$

$$i_o(t) = e^{-t}$$

