

Teaching and Learning with MATLAB and Simulink

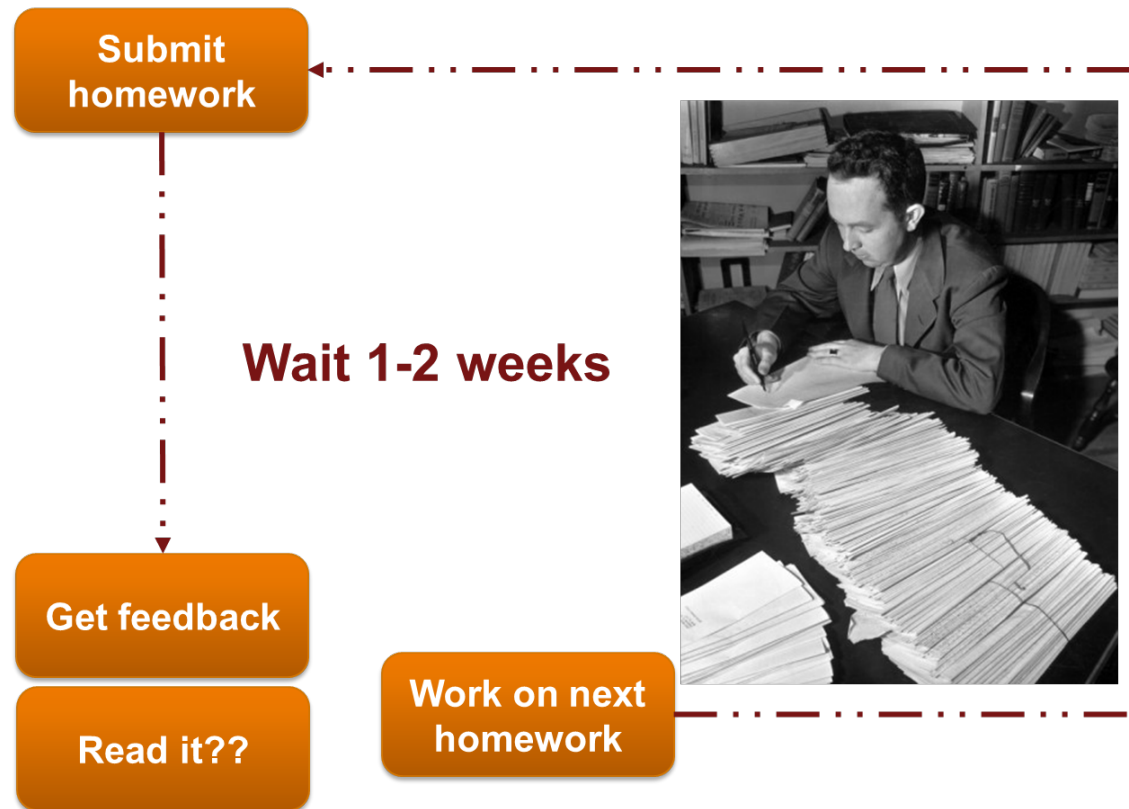
Árpád Forberger, application engineer
János Kertész, edu team lead

Overview

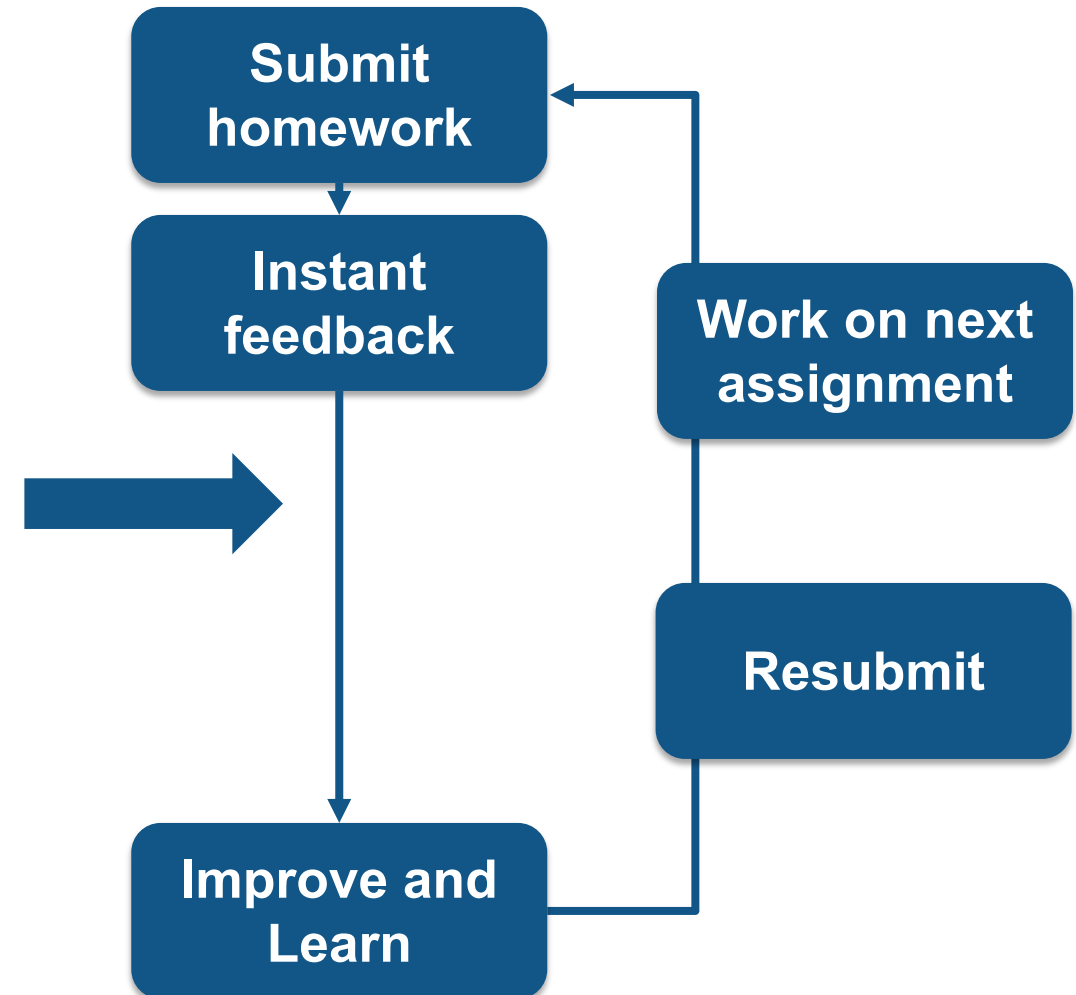
- What is MATLAB Grader?
- Who benefits from autograding MATLAB code?
- What can instructors use MATLAB Grader for?
- How it works (Product Demo)
- User Stories and Case Studies
- Teaching and Learning Resources
- How to get started using MATLAB Grader

What is MATLAB Grader?

Traditional Grading



Autograding



Transitioning from traditional assignments

Home Tools Assignment_v2.pdf x ? Sign In

1 / 3 44.6%

INTRODUCTION TO PROGRAMMING WITH MATLAB

Assignment 1: Convergent Series

Background

In mathematics, a series is the sum of the terms of an infinite sequence of numbers. A series is convergent if the sequence of its partial sums tends to a limit; that means that the partial sums become closer and closer to a given number when the number of their terms increases.

For more details, please refer to the [Wikipedia entry on Convergent Series](#).

Problem 1b: Estimating the value of Pi using Leibniz Series - Due 9/1

One of the methods to estimate the value of π is to use the Leibniz series expansion to a reasonably large number of terms and use the expression below to estimate the value of π .

$$\frac{\pi}{4} \approx 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \dots + \frac{(-1)^{n+1}}{2n-1} = \sum_{k=1}^n \frac{(-1)^{k+1}}{2k-1}$$

LaTeX: $\pi/4 \approx 1 - 1/3 + 1/5 - \dots = \sum_{k=1}^n (-1)^{k+1} / (2k-1)$

Using this expression, write a script to estimate the value of π using N terms. Your code should include the following variables:

```
N           % Number of terms used in the series expansion
estPi       % Value of  $\pi$  estimated using 'N' terms in the series.
```

Determine a value of N that ensures that the estimated value of π is within 0.1% of the actual value. Start with 10 terms, and increase or decrease the number appropriately to adjust the estimate.

You can use the Learner Template code provided below to develop your solution.

Learner Template

```
nTerms = ; % Number of terms to be used in the series expansion
% <Enter your code here>

estPi = ; % Estimated value of Pi for 'N' values.
```

Check to ensure that:

- the code does NOT use the variable 'pi' available in MATLAB.
- the output is numerically accurate for the number of series terms used.

Test Suite 1: Is MATLAB's built-in variable 'pi' being invoked in your code?

Feedback: The variable 'pi' available in MATLAB is being used in your code. Please retain only your estimated value of π under the variable name 'estPi'.

Test Suite 2: Is the estimated value of 'pi' acceptably accurate?

Feedback: Your estimated value doesn't fall within 0.1% of the expected value of π .



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CSU Demo > Week 1 Homework >

Untitled Problem

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Vector Creation (Leibniz series terms) Copy

hide details...

Consider the Leibniz series:

$$1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \dots$$

Write a script to generate a vector of the first twenty terms of this series. Assign the vector of series terms to a row vector variable named **LeibnizTerms**.

Solve this problem using vectorized code (i.e. do not use a loop in your solution.)

Files Referenced

None

Problem Type

Script

Code

Reference Solution Learner Template

```
1 k = 0:19;
2 LeibnizTerms= (-1).^k ./ (2 * k + 1);
```

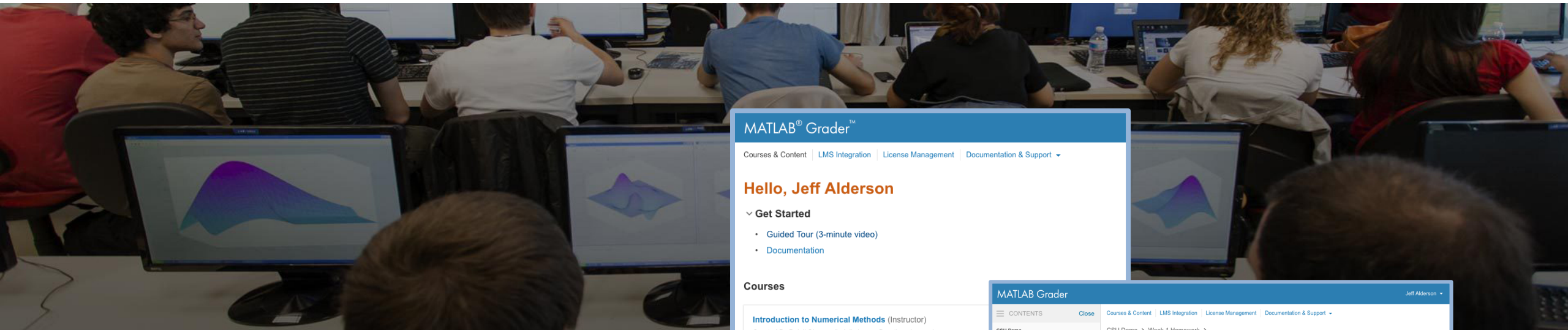
Assessment

> Test 1

Does variable LeibnizTerms have the correct values?

LeibnizTerms = Reference Solution?

MATLAB Grader



Create interactive course assignments



Automatically grade student work and provide feedback



Run your assignments in any learning environment

MATLAB[®] Grader[™]

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Hello, Jeff Alderson

Get Started

- [Guided Tour \(3-minute video\)](#)
- [Documentation](#)

Courses

Introduction to Numerical Methods (Instructor)
Created By Balaji Sharma (balaji.sharma@mathworks.com)
Duration (EDT): 01 Jan 2018 - 03 Sep 2018
3 Problems | 3 Students

Copy of Introduction to Programming (Instructor)
Created By Eric Davishahi (edavishahi@everettcc.edu)
Duration (PDT): 03 Apr 2018 - 15 Sep 2018
94 Problems | 0 Students

Example Problems (Instructor)
Created By Aditya Jain (aditya.jain@mathworks.com)
Duration (UTC): Not Specified - Not Specified
11 Problems | 0 Students

ADD COURSE

Content
Create problems outside of a course, storing them in collections or problems in courses.

ADD PROBLEM

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CSU Demo

- Reorder Content
- Week 1 Homework
 - Untitled Problem

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Collaborate with Instructors

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Vector Creation (Leibniz series terms)
hide details...

Consider the Leibniz series:
$$1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \dots$$
Write a script to generate a vector of the first twenty terms of this series. Assign the vector of series terms to a row vector variable named `LeibnizTerms`. Solve this problem using vectorized code (i.e. do not use a loop in your solution.)

Files Referenced
None

Problem Type
Script

Code

Reference Solution
Learner Template

```

1 k = 0:19;
2 LeibnizTerms = (-1).^k ./ (2 * k + 1);

```

Assessment

Test 1
Does variable LeibnizTerms have the correct values?
LeibnizTerms = Reference Solution?

Who will benefit from autograding MATLAB code?

- **Instructors** teaching large and/or introductory level courses
 - Off the shelf content and assessment examples to accelerate course development
 - Include MATLAB assignments for homework, exercises, and formative assessment
- **Teaching Assistants** and **Graders** for MATLAB-based courses
 - Less time spent grading code == more contact time with students
- **Students** get immediate feedback while mastering MATLAB skills and concepts

What can customers use MATLAB Grader for?

- Create and store **MATLAB based assignments** in a repository for later use
- Provide students with **additional practice problems** in the LMS
- Use MATLAB Grader for **in-class coding exercises** and quizzes
- View **student performance analytics** at the individual and aggregate levels.

Educators and Instructors are Teaching with MATLAB Grader

1,000+ instructors

100,000+ students

Over 6 million student submissions

What is LTI?

Learning Management System

MATLAB Problem FINAL ⓘ [Reports](#) [Choose Different Problem](#)

i The problem is saved as Final. It is now visible to learners when the course section is published. To edit this problem, click Set to Draft.

required fields *

Title ⓘ

Vector Creation (Leibniz series terms)

Problem Description and Instructions ⓘ

Consider the Leibniz series:

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Solve this problem using vectorized code (i.e. do not use a loop in your solution.)

Files Referenced ⓘ

None

[+ Add file](#)

Problem Type ⓘ

☒ Script ☐ Function

- LTI: Learning Tool Interoperability
- It's the **widely adopted, industry standard** that lets our application integrate with major LMS platforms.
- Nearly every LMS supports it

Score (0...1)

←

→

Course ID
Resource ID
Anonymous User ID
Role
Institution Credentials

MATLAB® Grader™

Learning Management System Integration

Integrate MATLAB Grader into your Learning Management System (LMS) so you can add MATLAB problems to your LMS course.

Select your LMS platform

Other

Check Whether MATLAB Grader is Already Integrated

If it is, you can start adding MATLAB problems to your LMS course. No additional steps are required. [How to Check?](#)

Primary Contact for your Institution

Your institution's primary contact may be able to help you with the integration.

fdsfsdfg fdsfsdf
3242343432

Integrating MATLAB Grader

If MATLAB Grader is not yet integrated into your LMS, follow your LMS's procedure for integrating external content. You'll be asked to provide credentials ("key" and "secret") and a "launch URL". Generate the key and secret, then refer to the instructions below.

Information You'll Provide to the LMS

Key	Generate Key and Secret
Secret	
Launch URL	https://lms-grader.mathworks.com/launch

Instructions

[View Instructions](#)

MATLAB Grader Product Demo

MATLAB® Grader™

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Hello, Jeff Alderson

▼ **Get Started**

- Guided Tour (3-minute video)
- Documentation

Courses Current Past

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▼ Week 1 Homework

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Untitled Problem

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Assessment

> **Test 1**
Does variable LeibnizTerms have the correct values?
LeibnizTerms = Reference Solution?

MATLAB Grader Product Demo

Instructor Workflow

Create Content

- Add a problem from Examples
- Create a problem from scratch
- Add to course syllabus

Share Content / Courses

- Invite TAs/graders/instructors
- Invite students

Assess Learning

- Download submissions or view in LMS
- Create grading rubrics

Student Workflow

Develop Solutions

- Write MATLAB solutions in the browser
- Use MATLAB desktop to develop solutions

Test and Submit

- Submit solutions for assessment
- Get instant feedback from test suites

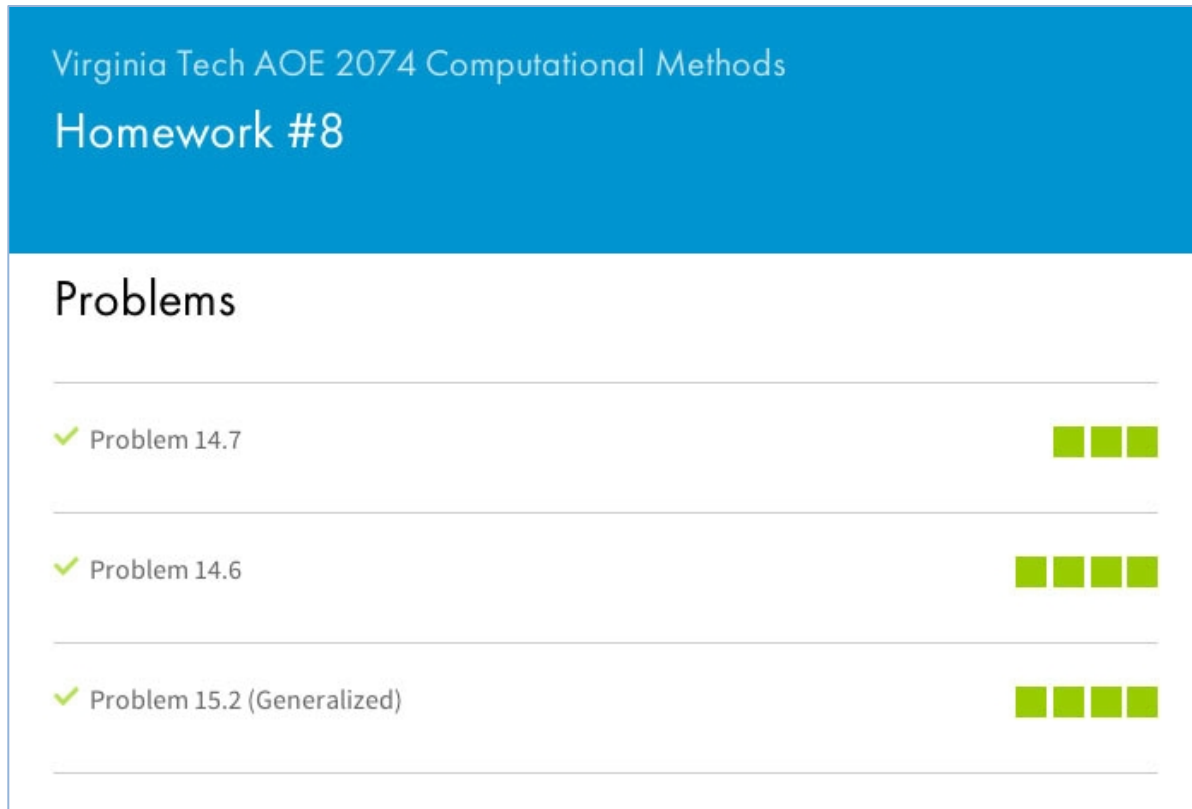
Refine Solutions

- Use Solution Map to write better code
- Compare solutions to peers

User Stories

Teaching Computational Methods to Second-Year Engineering Students at Virginia Tech

By Dr. Robert A. Canfield, Virginia Tech



Virginia Tech AOE 2074 Computational Methods
Homework #8

Problems

✓ Problem 14.7	■ ■ ■
✓ Problem 14.6	■ ■ ■ ■
✓ Problem 15.2 (Generalized)	■ ■ ■ ■

“The approach enables students to **learn more quickly** from their mistakes on their own.

The move to MATLAB Grader (Cody Coursework) has proven to be **beneficial** from a teaching perspective, and student feedback has been positive.”

- Dr. Canfield, Virginia Tech

“I live for green check marks.”

- Student at Virginia Tech

User Quotes

“I want to use this in **all of my courses** that involve MATLAB.”

- *Peter Corke, Queensland University of Technology
(Robotics Professor & Blackboard LMS user)*

“the lab time required was **reduced by more than 50%** because the students knew what to expect...”

- *Angelique Janse van Rensburg, Professor, North-West University
(Linear Systems course)*

Teaching and Learning Resources

**Deans
Faculty**

“I want graduate students to learn MATLAB for research.”

**Instructors
TAs**

“I want students to know basic MATLAB & Simulink before they come to my class.”

“I am spending way too much time writing and grading programming assignments.”

“I can’t engage my students with a static textbook. I need something interactive.”

**Deans
Admins**

“I want students to graduate with proof of mastery of MATLAB skills.”

Self-Paced Online
Courses

Onramps and Comp
Math Courses

MATLAB Grader and
MATLAB Courseware

Interactive Publisher
Content / Books

Certification

Self-Paced, Online Training for MATLAB & Simulink

The screenshot shows the MATLAB Deep Learning Onramp interface. The browser address bar displays the URL: `https://matlabacademy.mathworks.com/R2018b/portal.html?course=deeplearning#chapter=2&lesson=1§ion=1`. The page title is "Deep Learning Onramp (0% complete)" and the user is "Stephen Frail".

The main content area is titled "2.1 Course Example - Identify Objects in Some Images". It contains a task pane on the left and a workspace on the right.

Task 1

Task 2

You can use the `imshow` function to display an image stored in a MATLAB variable

```
imshow(I)
```

TASK

Display the imported image in the variable `img1`.

[Hint](#) | [See Solution](#) | [Reset](#) | [Submit](#) | [Next task](#)

Test Results: Correct!

✓ Is `img1` displayed correctly?

View image files

Instructions are in the task pane to the left. Complete and submit each task one at a time.

Task 1

Import an image

```
img1 = imread('file01.jpg')
```

Task 2

View image

```
imshow(img1)
```

Task 3

Import and view more images

The workspace on the right shows the variable `img1` as a `227x227x3 uint8 array`. Below the variable name is a preview of the image, which is a landscape photo of a beach and trees.

Campus-Wide Online Training

Hands-on MATLAB and Simulink experience

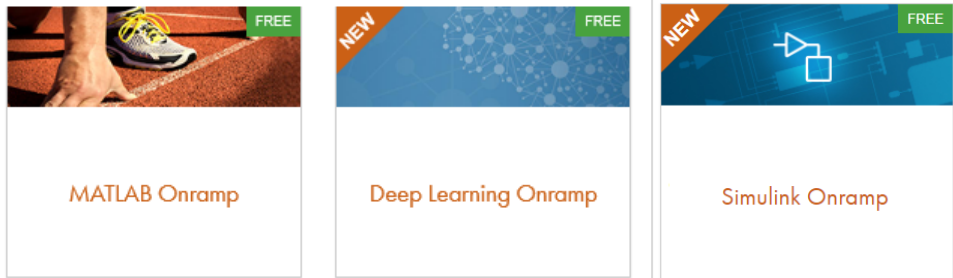
Measurable progress report and completion certificate

Interactive lessons with immediate feedback

24/7 availability

Self-Paced Online Courses

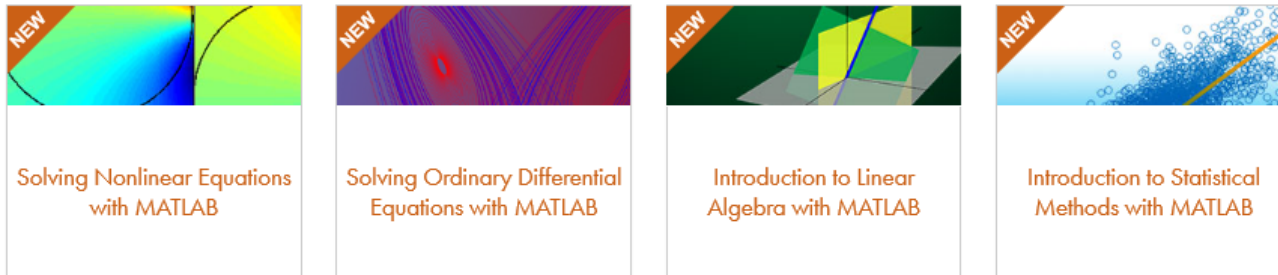
Get Started



5 free courses – available for everyone
+ Machine Learning Onramp
+ Stateflow Onramp

Computational Mathematics

*Available only to users at universities that offer campus-wide online training access.

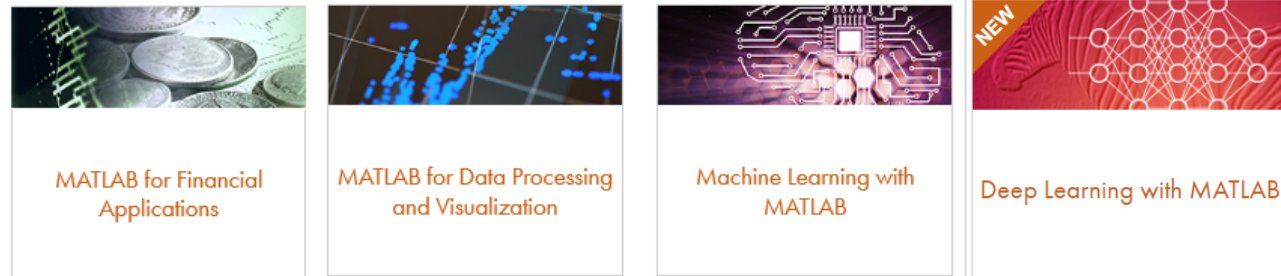


4 courses targeting MATLAB skills needed in the classroom

Core MATLAB Functionality

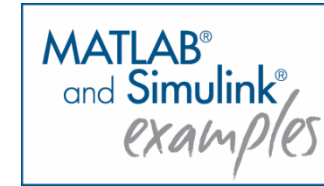


Data Analytics



6 in-depth courses for enhancing MATLAB skills

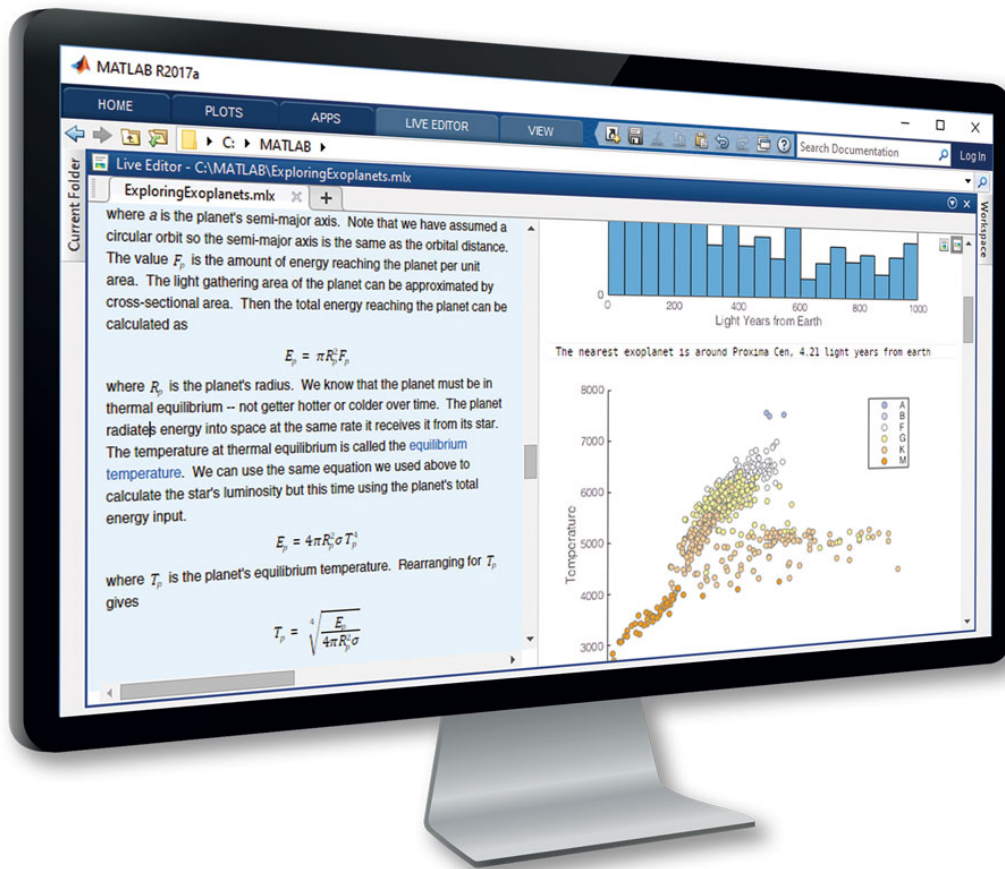
MATLAB and Simulink Based Books



- More than 2000 titles in 26 languages for educational and professional use
- Subjects include:
 - Biosciences and Biomedical
 - Chemistry and Chemical Engineering
 - Control Systems
 - Digital Signal Processing
 - Earth Sciences
 - Economics and Computational Finance
 - Image and Video Processing
 - Mathematics
 - Mechanical Engineering
 - Neural Networks and Fuzzy Logic
 - Physics
 - Programming and Computer Science
 - Robotics
 - System Modeling and Simulation



Teach with MATLAB Live Editor



MATLAB in an Executable Notebook

Use live scripts to create **engaging lectures** that combine explanatory text, mathematical equations, code and results

Share live scripts directly with colleagues or students

Work in a **single environment** to eliminate context switching

MATLAB Courseware

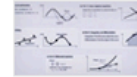
Downloadable sets of curriculum materials for educators based on MATLAB and Simulink.

- Video lectures
- Classroom materials
- Textbook references
- Homework assignments
- MATLAB and Simulink code examples

Topics Include:

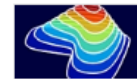
- Introduction to Programming
- Introduction to Engineering
- Bioengineering and Biological Sciences
- Chemistry
- Earth, Ocean and Atmospheric Sciences
- Economics and Finance
- Electrical and Computer Engineering
- Mechanical and Aerospace Engineering
- Mathematics
- Physics and Astronomy

Mathematics



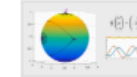
Applied Numerical Methods with MATLAB

Professor Steven C. Chapra
Tufts University



Numerical Computing with MATLAB

Cleve Moler
MathWorks



Differential Equations and Linear Algebra

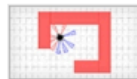
Professor Gilbert Strang
Massachusetts Institute of Technology
Cleve Moler
MathWorks



Teaching Calculus with MATLAB

Integrating MATLAB into a Calculus Curriculum

Electrical and Computer Engineering



Control of Mobile Robots

Professor Magnus Egerstedt
J.P. de la Croix
Georgia Institute of Technology



Introduction to Model-Based System Design

Professor Marc Herniter
Professor Zachariah Chambers
Rose-Hulman Institute of Technology



Control Tutorials for MATLAB and Simulink

Professor Bill Messner
Professor Dawn Tilbury
Professor Rick Hill



Advanced Model-Based System Design

Professor Zachariah Chambers
Professor Marc Herniter
Rose-Hulman Institute of Technology

Introduction to Programming



Introduction to MATLAB Programming

Professor Kathleen Ossman
Professor Gregory Bucks
University of Cincinnati



Introduction to MATLAB

Professor William J. Palm, III
University of Rhode Island

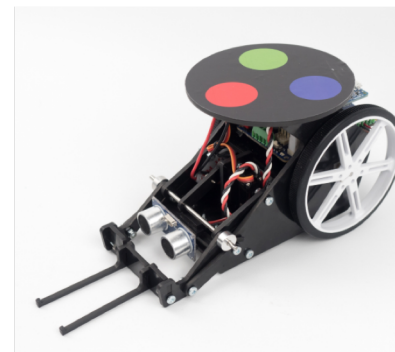
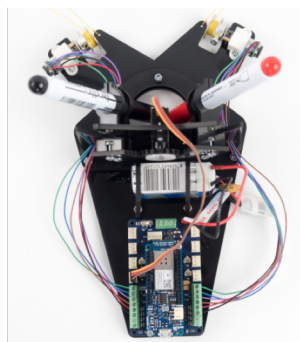
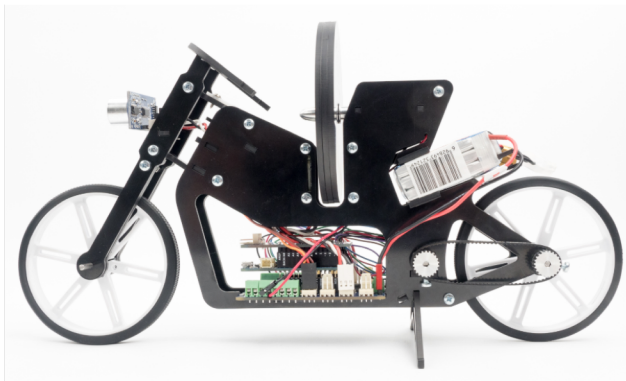
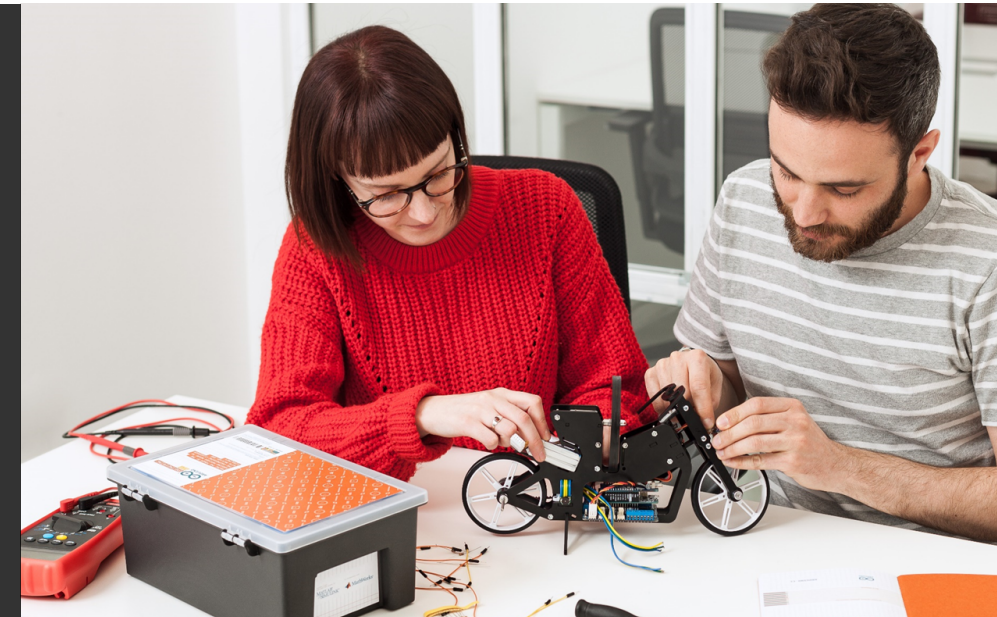
Low-Cost Hardware Curriculum Support for MATLAB

Arduino Engineering Kit

Includes Arduino MKR1000 board and all components to create **three engaging, hands-on projects**:

- self-balancing motorcycle
- mobile rover
- drawing robot

Online learning materials that facilitate project-based learning



Project-Based Learning with Low-Cost Hardware

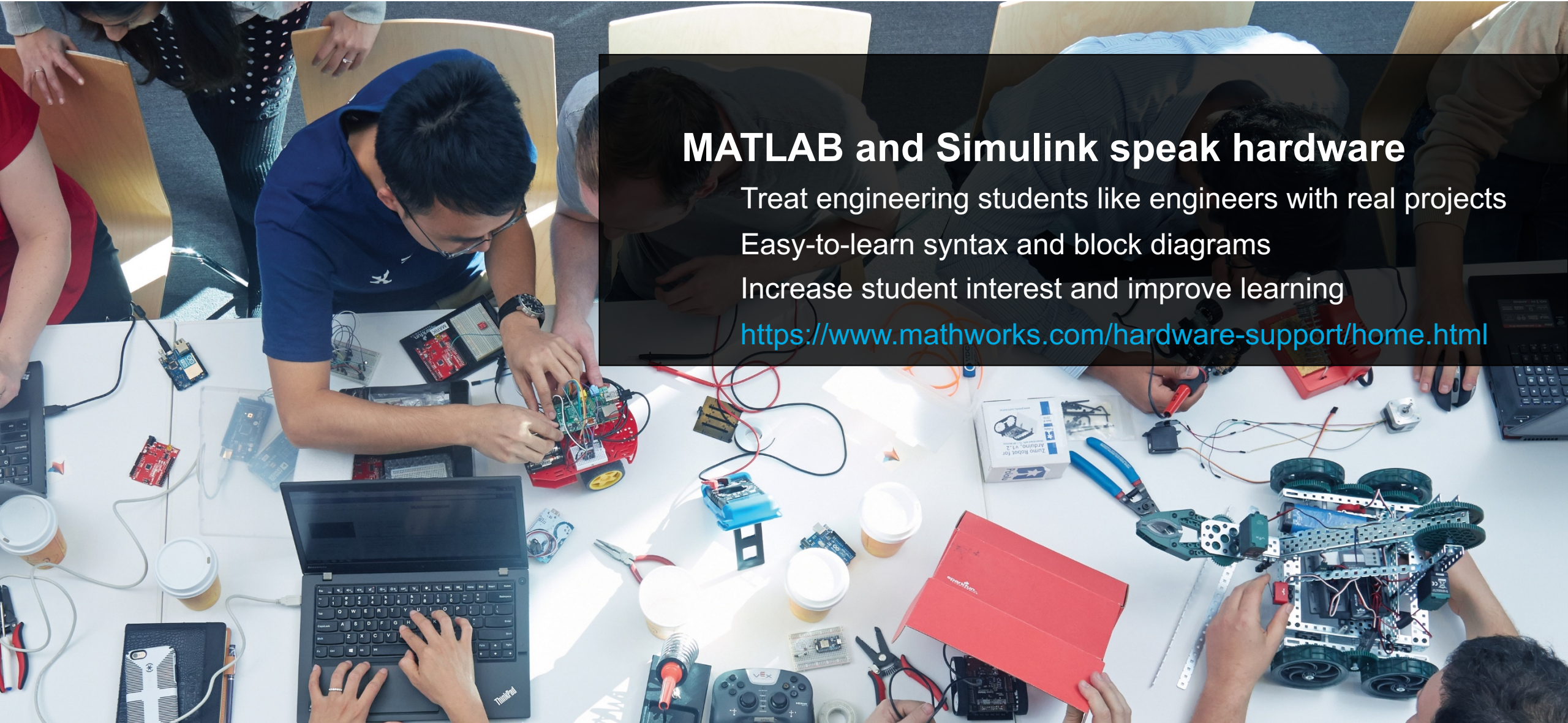
MATLAB and Simulink speak hardware

Treat engineering students like engineers with real projects

Easy-to-learn syntax and block diagrams

Increase student interest and improve learning

<https://www.mathworks.com/hardware-support/home.html>



Get started on MATLAB Grader **for free** today!

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

For more information about Teaching and Learning with
MATLAB and Simulink:

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

Q&A