MATLAB EXPO 2017
Leveraging MATLAB and Simulink for Higher Education: An Overview of MathWorks Resources for Academia

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Challenges in Teaching Engineering

- Address & solve real-world problems

- Engaging, demanding and creative courses

- Engineering practice not just science and principles
Disruptive Trends in Engineering Education
Experiential Learning
Online Learning
Collaborative Learning
Experiential Learning

- Focus not just on equations and theoretical examples, but also towards **real-time** implementation and **real-world** examples

- Use of hardware to demonstrate concepts

- Project-based Learning
Online Learning

- Connectivity – laptops, mobiles
- Anytime-anywhere learning
Collaborative Learning

- Student Competitions and Hackathons
  - Work on design to implementation together
  - Examples: Formula Student, Robocon India, BAJA SAE India, Kaggle

- MOOCs
  - Run in place of traditional courses in a few colleges
  - Students use credit from MOOCs towards their coursework
Agenda

Experiential Learning
- Interactive Live Editor and App Designer
- Hardware Connectivity and Internet of Things

Online Learning
- MATLAB Online and MATLAB Mobile
- Cody Coursework
- MATLAB Academy
- MATLAB Courseware
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Editing and Running MATLAB Code Today

- Plain-text editing
- Output goes to Command Window
- Multiple figure windows appear
- Equations, images, and hyperlinks only appear if published
Calculus I, II and III

Multivariate integration, differentiation, series, limits, 3D curves and surfaces

Find the derivative, integrand and Taylor series of $\log(x)$.

```matlab
syms x
f = log(1/x)

T = log(x)

df = diff(f)

df = -1/x

F = int(f)

F = x*(log(x)/x) + 1

T = taylor(f,x,'ExpansionPoint',1)

T = \frac{x-1}{2} - \frac{x-1}{3} + \frac{x-1}{4} - \frac{x-1}{5} + 1

Plot 3D surfaces

syms f(t) u v x(u,v) y(u,v) z(u,v)
```
Using the Live Editor

- Accelerate Exploratory Programming
- Create an Interactive Narrative
- Teach with Live Scripts
Sharing Live Scripts

Colleague with MATLAB

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HTML

PDF
Demo: Apps

- Apps Tab in MATLAB

- Creating an App/UI in MATLAB
Developing a UI in MATLAB

Programmatic Approach

- MATLAB code to layout and program
- Full control of UI initialization and setup

GUIDE (GUI Development Environment)

- Interactive UI construction kit
- Layout the UI interactively
- Program on an auto-generated template

App Designer (from R2016a)
App Designer

1) Define UI layout
2) Drag & Drop UI elements
3) Develop code for auto-generated callbacks

Introduced in R2016a

Built on JavaScript; useful in deploying MATLAB apps on the web; uses ‘methods’

Key Features:

Interactive Design Environment
Set of Standard User Interface Components
Gauge, Knob, Switch, and Lamp Components
New Code Format for Apps compared to GUIDE
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Demo: Hardware Connectivity

- Raspberry Pi for Video Processing
Why Hardware? Why Project-based Learning?

Changing Hardware Trends -
It’s everywhere!

- Prototyping is easier and cheaper
- HW companies developing “dual” maker & commercial hardware
- More powerful hardware
- Everyone is connected
- More data is collected
Examples of MathWorks Supported Hardware

- Arduino
- Lego EV3
- Raspberry Pi
- Android/iOS Devices
- Kinect for Windows
- BeagleBone Black
- Texas Instruments
- STM Electronics
- Freescale
- Zynq SDR
Getting Hardware Support Packages

- **Requirement**
  - MATLAB and Simulink

- **Free to download**

- **Connects to**
  - Raspberry Pi, Arduino, Mobile sensors and many other hardware
Simulink Support Package for Raspberry Pi Hardware

- Communications System Toolbox
- Computer Vision System Toolbox
- Control System Toolbox
- DSP System Toolbox
- DSP System Toolbox HDL Support
- Embedded Coder
- Embedded Coder Support Package for Texas Instruments
- Fuzzy Logic Toolbox
- HDL Coder
- HDL Verifier
- Image Acquisition Toolbox
- Instrument Control Toolbox
- Model Predictive Control Toolbox
- Neural Network Toolbox
- OPC Toolbox
- Phased Array System Toolbox
- Report Generator
- Robotics System Toolbox
- Robust Control Toolbox
- SimEvents
- SimRF
- Simscape
- Simulink 3D Animation
- Simulink Coder
- Simulink Control Design
- Simulink Design Optimization
- Simulink Design Verifier
- Simulink Desktop Real-Time
- Simulink Extras
- Simulink Real-Time
- Simulink Support Package for Arduino Hardware
- Simulink Support Package for Raspberry Pi Hardware
- Simulink Support Package for Samsung GALAXY Android
- Simulink Test
- Simulink Verification and Validation
- ALSA Audio Capture
- ALSA Audio Playback
- eSpeak Text to Speech
- GPIO Read
- GPIO Write
- ThingSpeak Write
- UDP Receive
- UDP Send
- V4L2 Video Capture
- GPI0 10 (Green)
- GPI0 17
- GPI0 4
Internet of Things - ThingSpeak

- Collect data from internet-connected sensors and run MATLAB analytics on the cloud using functions from:
  - Statistics and Machine Learning Toolbox
  - Signal Processing Toolbox
  - Curve Fitting Toolbox
  - Mapping Toolbox
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MATLAB Online

Access MATLAB from a web browser.

• Demo

No Download/Installation
Version Consistency
File Sharing
Everywhere Access

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MATLAB Online

Your files and data on the cloud

- 5 GB of cloud storage on MATLAB Drive
- Sync files between computers and MATLAB Online with MATLAB Drive Connector
- Session persists across computers
- Files and workspace are synced with MATLAB Mobile
MATLAB Mobile

- Available for iPhone, iPad, iPod and Android devices.
- Lets you connect to a MATLAB session running on your computer, or on MathWorks Cloud.
- Smart phone as a sensor platform
MATLAB Mobile

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Hardware Sensor Platform: MATLAB Mobile
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Before we start – a few questions

- How do you test learning of concepts?
- How do you typically evaluate code submitted by students?
- Is evaluation of code time-consuming?
Cody Coursework

- Visual environment to create MATLAB problem sets
- Instructors can set up MATLAB assignments and automatically evaluate them
- Students can test their solutions obtaining immediate feedback

Homework assignments

Exams

Practical sessions

Many others (e.g., learn MATLAB, share problems)
Workflow

Faculty creates a course in Cody Coursework
  • Assignments with Problem Sets
  • Invites Students to the course

Student receives an email with an invite to the course
  • Assignments with problems sets due on a particular date
  • Students solves the problems, gets instant feedback and submits the assignment

Learning analytics
  • Faculty is able to see how many students attempted the problems in the assignment, how many got it correct, number of attempts
  • Faculty also able to download the MATLAB code submitted and the submission data in CSV format

https://coursework.mathworks.com
Cody Coursework

- MathWorks hosted and runs a cloud version of MATLAB
  - No local installation of MATLAB necessary

- Catalog of courses and problems
  - Basic MATLAB
  - Numerical Methods
  - Calculus
  - Control Systems
  - Signal Processing

- Requirements:
  - Instructor: License association
  - Student: MathWorks account
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Challenge

Tool
Teaching

Students do not know MATLAB
I do not want to teach MATLAB
Difficult in classroom
Outcome is not satisfactory
<table>
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<tr>
<th>Mathematical Modeling and Data Analytics</th>
<th>Signal/Image Processing &amp; Communications</th>
<th>Control Systems, Robotics and Automation</th>
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<tbody>
<tr>
<td>Statistical Methods in MATLAB</td>
<td>Signal Processing with MATLAB (Simulink)</td>
<td>Simulink for System and Algorithm Modeling</td>
</tr>
<tr>
<td>Machine Learning with MATLAB</td>
<td>Image Processing with MATLAB</td>
<td>Stateflow for Logic Driven System Modeling</td>
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<tr>
<td>Optimization Techniques in MATLAB</td>
<td>Computer Vision with MATLAB</td>
<td>Control System Design with MATLAB and Simulink</td>
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<td>MATLAB for Data Processing and Visualization</td>
<td>Communication Systems Modeling with MATLAB (Simulink)</td>
<td>Designing Robotics Algorithms in MATLAB</td>
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<td></td>
<td>Designing LTE and LTE Advanced Physical Layer Systems with MATLAB</td>
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</table>
MATLAB Academy

- Interactive self-paced MATLAB training
- Easy access from computers
- Built-in access to MATLAB Online
- On-demand access to content
- Demonstrations, quizzes, and hands-on MATLAB practice sessions
- Short and well defined modules
- Demo video
MATLAB Academy

MATLAB Onramp
Complimentary training - 2 hrs duration

MATLAB Fundamentals

MATLAB Programming Techniques

MATLAB for Data Processing and Visualization

MATLAB for Financial Applications

Machine Learning with MATLAB

MATLAB Academic Online Training Suite (MAOTS)

- Includes all MATLAB Academy Courses
- Bundled with the University Campus License
- Available to all registered University staff/students
- Access to course completion certificate
New Customized Course Offering: System Modeling for Control Systems and Image Processing

- **Customized course** for Indian academic audience based on trends in industry

- **Learning Outcome:**
  - Model-Based Design workflow including physical modeling, code generation, rapid prototyping, in-loop verification

- **Use cases:**
  - Design of Control System for DC motor
  - Object Surveillance System

- **Tools covered:**
  - MATLAB, Simulink, Simscape, Stateflow, Control Systems Toolbox, Image Processing Toolbox, Computer Vision Systems Toolbox, Embedded Coder
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MATLAB Courseware

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

Digital Speech Processing

Professor Lawrence Rabiner
Rutgers, The State University of New Jersey

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

Embedded Control and Mechatronics

Professor Farzad Pourboghrat
Southern Illinois University, Carbondale

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Learn how to use these resources in the next session on ‘Building a Course Implementation Plan’
WHAT IF EVERYONE ON CAMPUS HAD MATLAB?

More than 1 million students and 700 universities around the world—including the top 10 ranked universities—have unlimited access to MATLAB and Simulink with a Total Academic Headcount (TAH) license.

**HANDS-ON LEARNING**

42,000

Faculty and students using MATLAB to program hardware

"On multidisciplinary projects, students with quite different educational backgrounds can work together more easily because they are using the same tools."

Professor Jakob Stoustrup, Aalborg University

**JOB OPPORTUNITIES**

82%

Fortune 100 companies with a MATLAB license

"If you want to work at Google, make sure you can use MATLAB."

Jonathan Rosenberg, Senior Vice President of Products, Google

**RESEARCH PRODUCTIVITY**

1,970,000

Google Scholar results referencing MATLAB

"Our teams are here to do world-class research, and easy access to MATLAB enables them to be their most productive."

Shahriar Shenoy, Director of Research Computing, Albert Einstein College of Medicine of Yeshiva University