Empowering Students in an Introductory Programming Course

TICKLE
COLLEGE OF ENGINEERING
THE UNIVERSITY OF TENNESSEE, KNOXVILLE

THE UNIVERSITY OF TENNESSEE

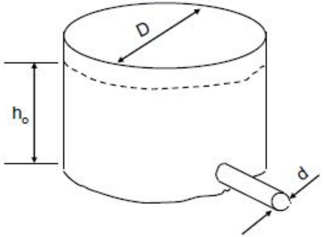
Amy Biegalski, PE, PhD
biegalski@utk.edu

Course Background

- For Engineering majors
- ~300 students - 30 per class
- 1 of 4 core courses in our Engineering Fundamentals curriculum

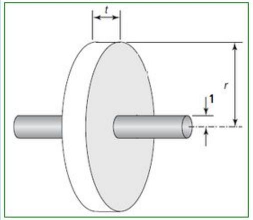
Primary Challenge:	Solution:
Create a curriculum effective for a broad range of students	Demonstrate applicability of programming to each student's chosen area of study

Add Context



Solve this ODE to determine the height of water, h(t), in a draining tank at time t=4, using MATLAB's symbolic toolbox:

$$\frac{dh(t)}{dt} = -\sqrt{2g}\frac{\mathrm{d}^2}{\mathrm{D}^2}\sqrt{h(t)}$$



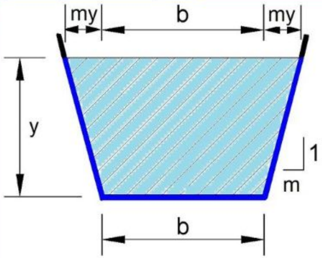
Design a flywheel to smooth out variations in the speed of its shaft by **minimizing the mass** of the flywheel. Use **fmincon** to determine the optimum design variables **r** and **t**. The mass of the flywheel is

$$mass = .28\pi(r^2 - 1^2)t$$

I, the mass moment of inertia of the flywheel shown in the equation below, must be **greater than 0.816**

$$I = \frac{\pi}{2757}(r^4 - 1^4)t$$

2.
2775



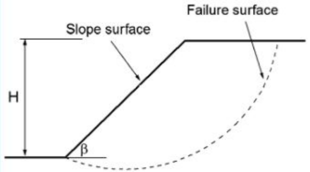
As a civil engineer, you must design a trapezoidal open channel to carry irrigation water. The channel with the minimum "wetted" perimeter is the best hydraulic cross section with the same area of flow since lining and maintenance expenses will reduce substantially.

Use fmincon and 3 variables, y, m, and b, to determine the optimal dimensions to minimize the wetted perimeter for a cross-sectional area = 50 m^2

Hint: the wetted perimeter of the structure has 3 sides (shown as blue). Use Pythagorean theorem instead of trig functions for determining your optimization equation. template m-file

NOTES | IMAGES | DISCUSS | UNITS | STATS | HELP

Part	Description	Answer	Chk	History
A.	What will be the side slope, m, for the best hydraulic cross section?	A S	20 pts. 100% 2% try penalty Hints: 0,0	# tries: 0 Show Details Clear tries and answer

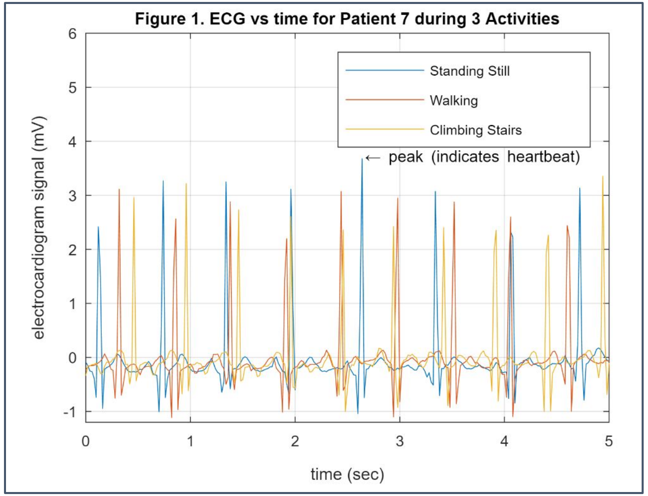


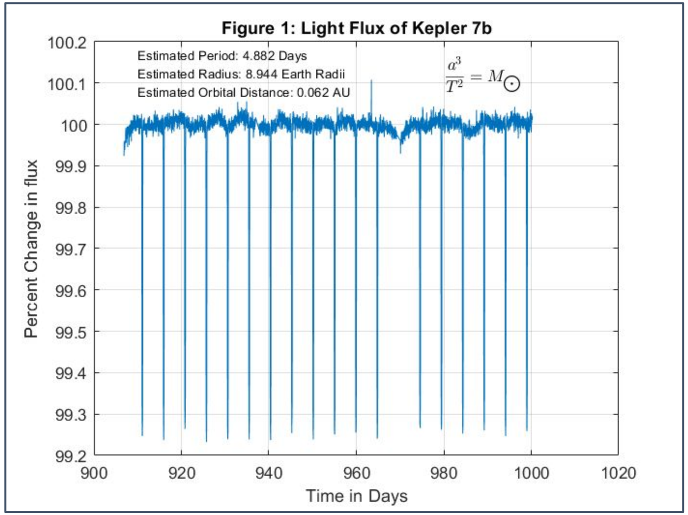
Write a MATLAB **code segment** to analyze the slope stability at a particular site.

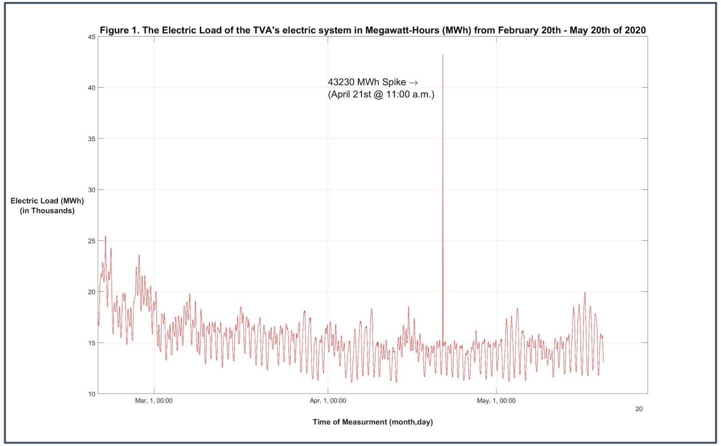
```
FS=c/(H*gamma*N)
if FS>1.6
slope='SAFE'
else
slope='UNSAFE'
end
```

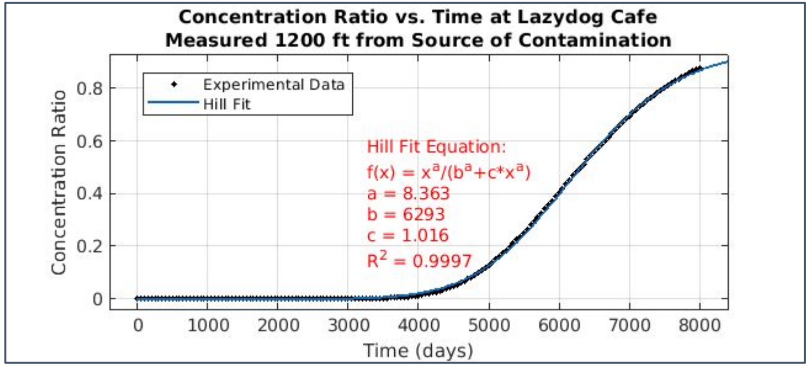
Save | Reset | Save and Submit to MATLAB | Points: 12.5

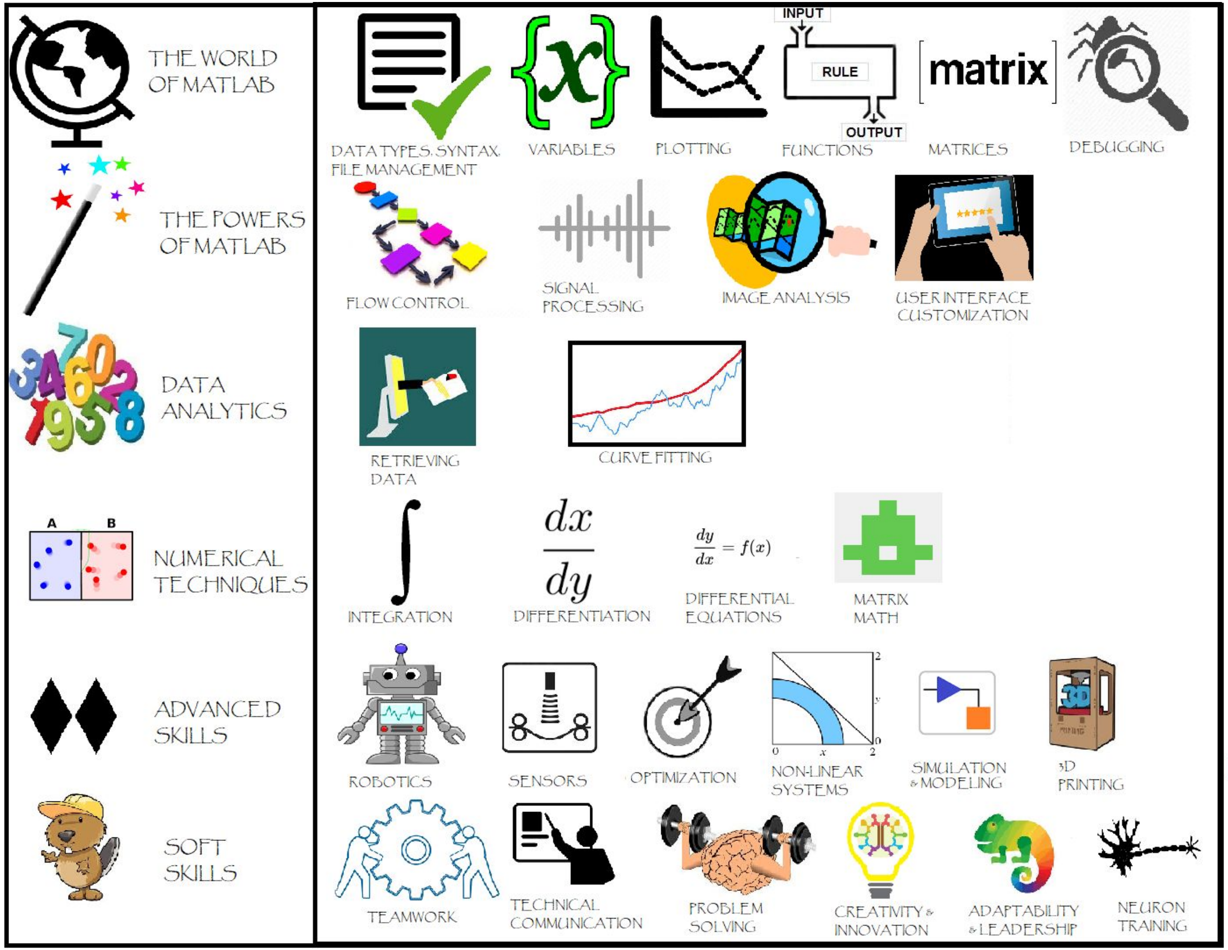
Incorporate Choice











Tracking

Learning Badges

Learning Badges

EF 230 Fall, 2020
User: abiegals

- Control Panel
- Student Lists
- Grade Entry
- Grade Stats
- Edit page
- Browse
- Logoff

- Announcements
- Instructors
- Syllabus
- Semester Calendar
- Section Info

- MWF Learning
- TR Learning
- Due Dates
- Projects
- Drop Box
- Policies
- Exam Results

		Debugging using live scripts Debugging in-class practice VolPoll Plotting Project Introduction Recorded Video			
	Fri Aug 28	Plotting Project Work Day			
4	Mon Aug 31	*Functions* Intro to Functions Built-In Functions Creating Functions Example Functions Matrices as function inputs Add to Path Best Practices Parsons Puzzle § Test Cases In-class Practice VolPoll Practice Recorded Video	Functions PreLab	Function Practice	
5	Wed Sep 2	*Subfunctions and Anonymous Functions and Quiz 1 Review* Intro Subfunctions Using a Main Function Anonymous Functions § Subfunctions in-class practice Anonymous Functions in-class practice VolPoll Quiz 1 Format and Review Recorded Video	Sub & Anony. Functions PreLab		Team Maker Survey
	Fri Sep 4	Quiz 1 Review		Quiz 1: Practice	
	Mon Sep 7	**Module 1 Quiz - Basics, Plotting, and Functions**			Plotting Project due Sep 8
		Module 2 The Powers of MATLAB:Flow Control, Signals, Images			
6	Wed Sep 9	*Flow Control* Intro to Flow Control Conditionals - If For loops While loops Break Continue Pause Pseudocode and Flowcharts Comparison of Loops Parsons Puzzle § VolPoll Conditionals in-class practice For loop in-class practice More Loop in-class Practice Practice Assignment Recorded Video	Flow Control PreLab	Flow Control Practice	
	Fri Sep 11	Flow Help Session			
7	Mon Sep 14	*Team Day - Introduction to Virtual Robots* Intro Hacklab rules Intro to the iRobot Create iRobot Create toolbox § Practice Recorded Video	Robot PreLab	Robot Team Day	

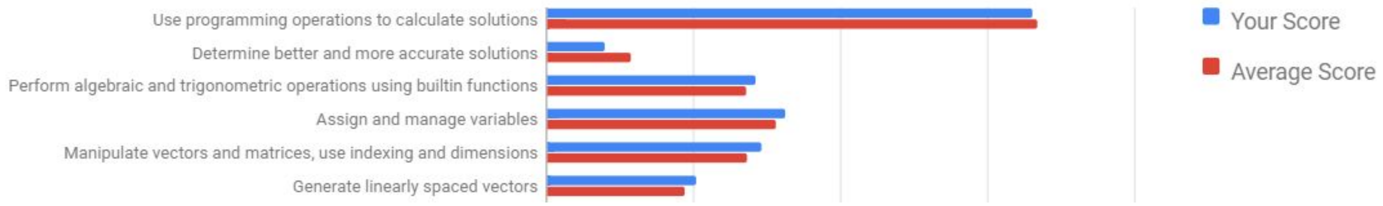
Tracking

Programming Power Meter

The bar chart below can be used to visualize your progress on the individual learning objectives in each category and compare to the class average

Score Breakdown for Objective 1: Build

Build: Build programs to solve engineering problems



Primary Challenge:

Create a curriculum effective
for a broad
range of students

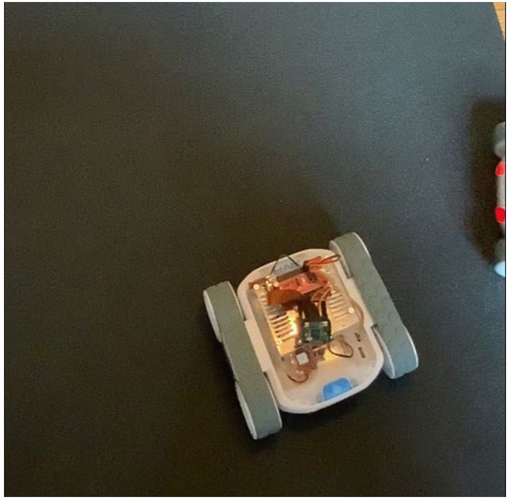
Intimidated by coding with little coding experience → High Achievers with substantial background

Freshman Sophomores → Juniors Seniors Non-Trad

Solution:
Flipped PBL course incorporating hands-on technology

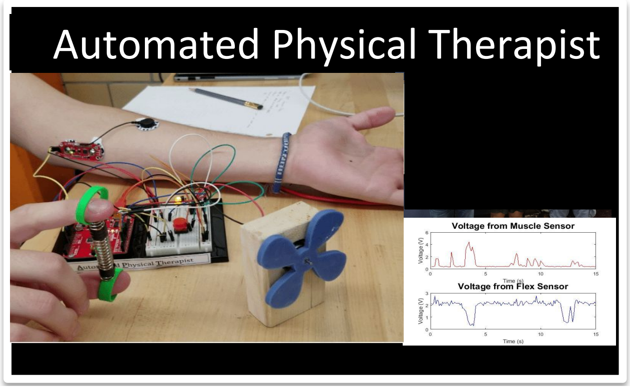
- Coding more approachable, more apparent
- High achievers can create impressive projects
- More discussion, peer instruction, less stress - more success

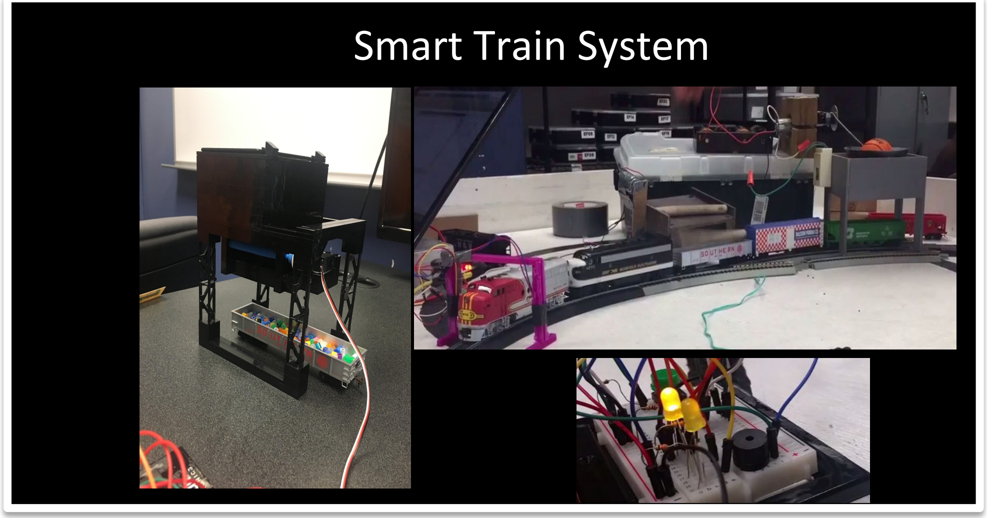
Student Projects use our MATLAB Toolboxes for Raspberry Pi controlled iRobot Create [1] and Sphero RVR



[1] UTK EF Roomba Toolbox is based off the MATLAB toolbox for iRobot Create, developed by Joel M. Esposito, USNA, www.usna.edu/Users/weapsys/esposito/_files/roomba.matlab/

Projects - Arduinos, Raspberry Pi's, iRobot Create with Pi





Facilitating Effective Teamwork

- Pre-project survey to inform team assignments
- Team Contract
- Teammate Assessment
- TA Team Mentors

Teaching Online

MATLAB Online
MATLAB Connector
MATLAB Drive
Virtual Create Robots [1]
Webcam and Sound

[1] iRobot Create Simulator Toolbox, Copyright 2010 Cornell University. dfan@cs.cornell.edu