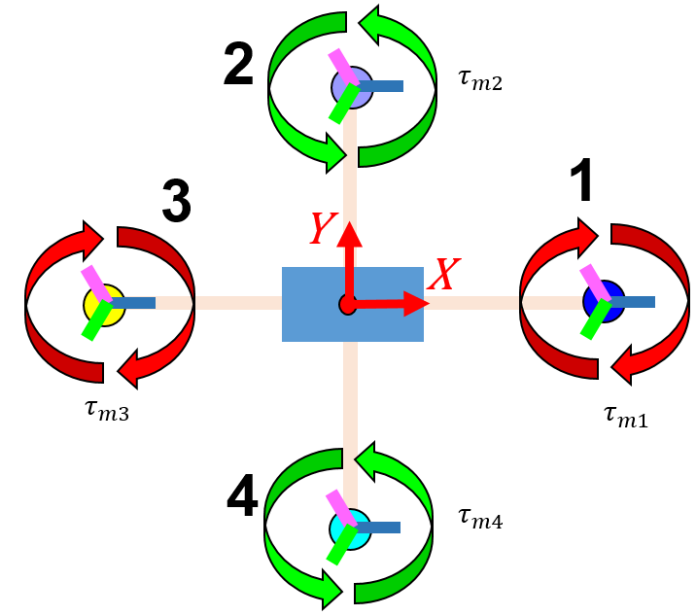
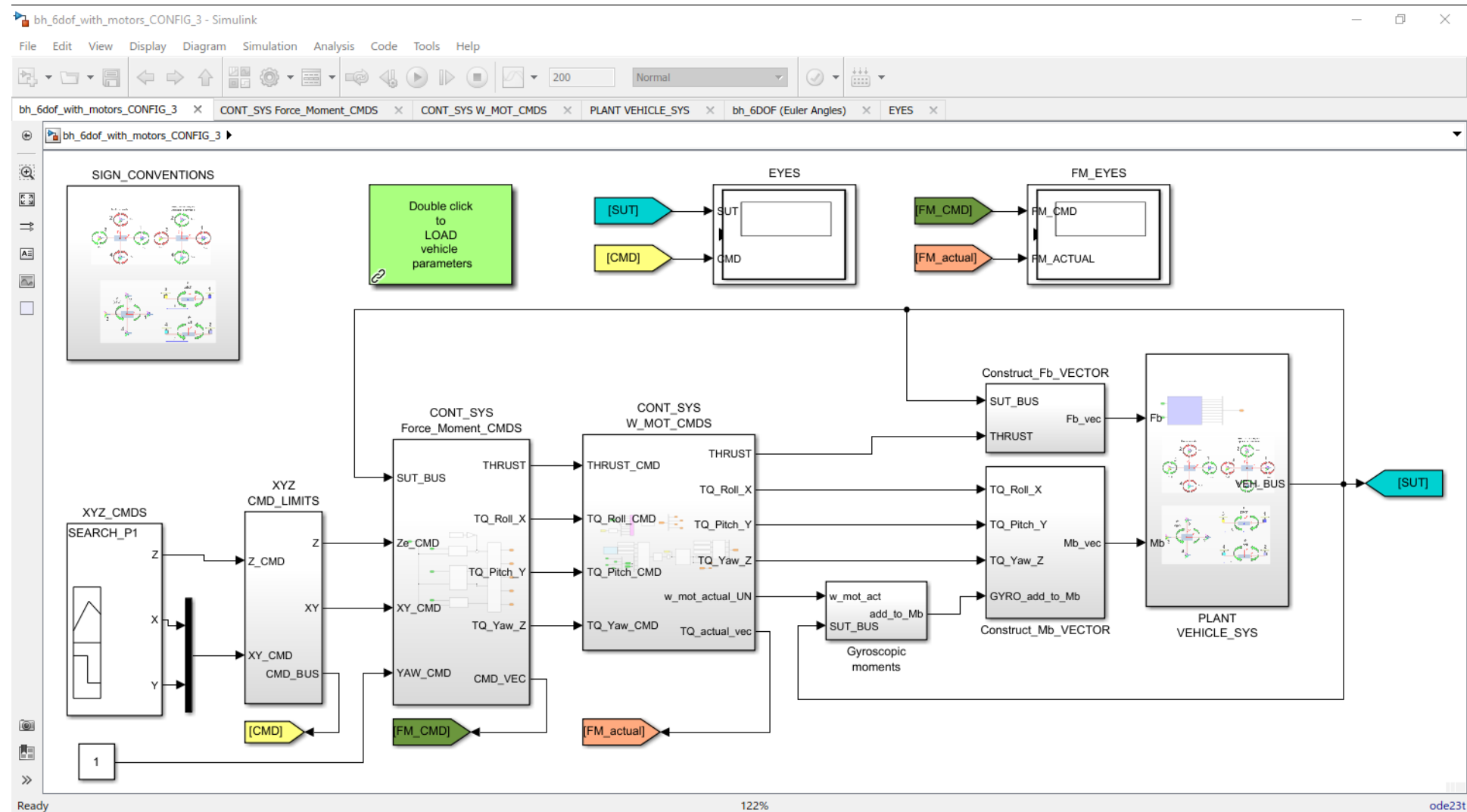
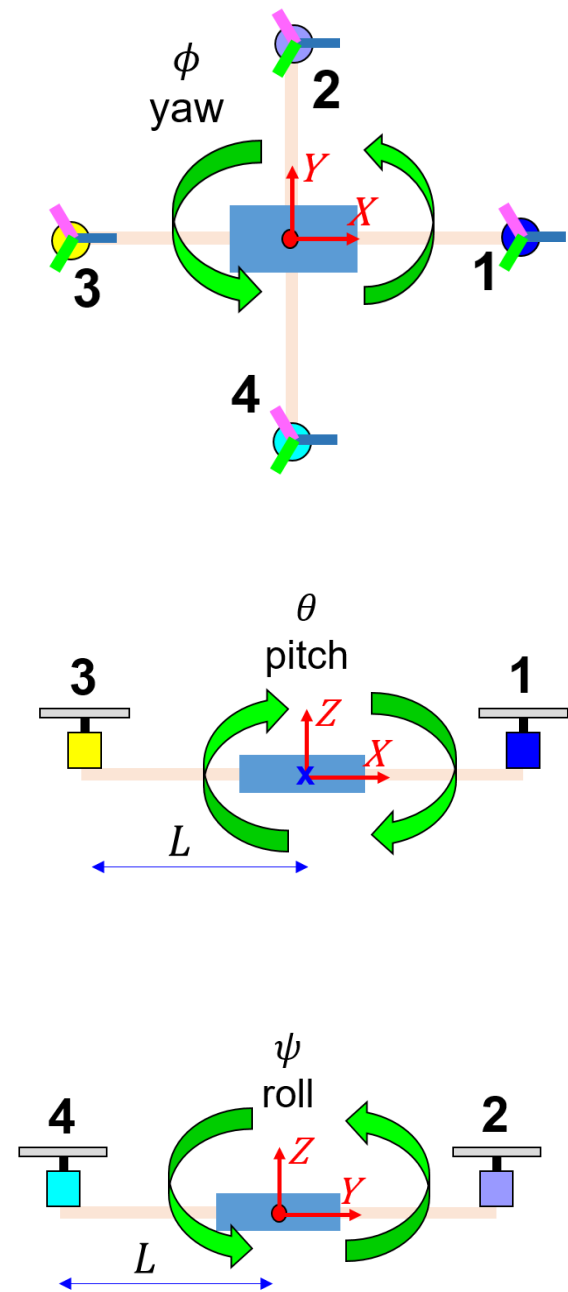


Quadcopter Modelling and simulation

- *a case study for encouraging deeper learning engagements with students.*

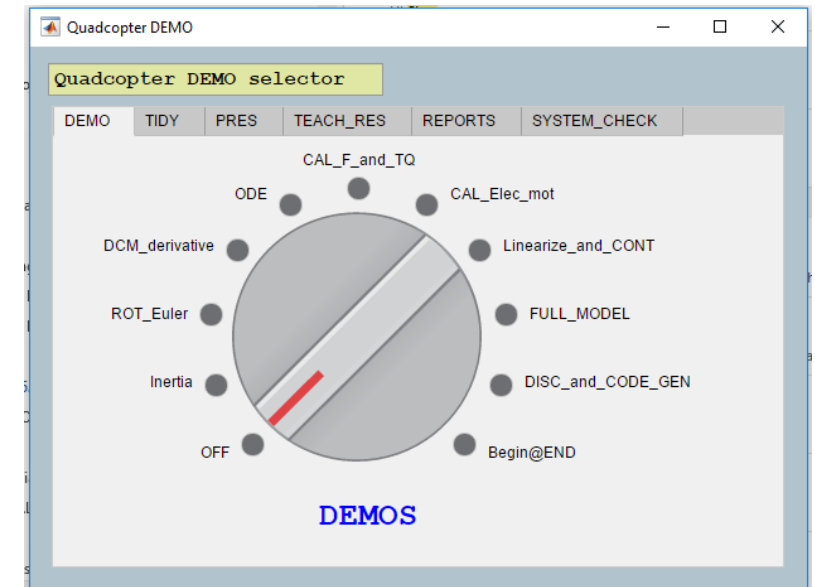
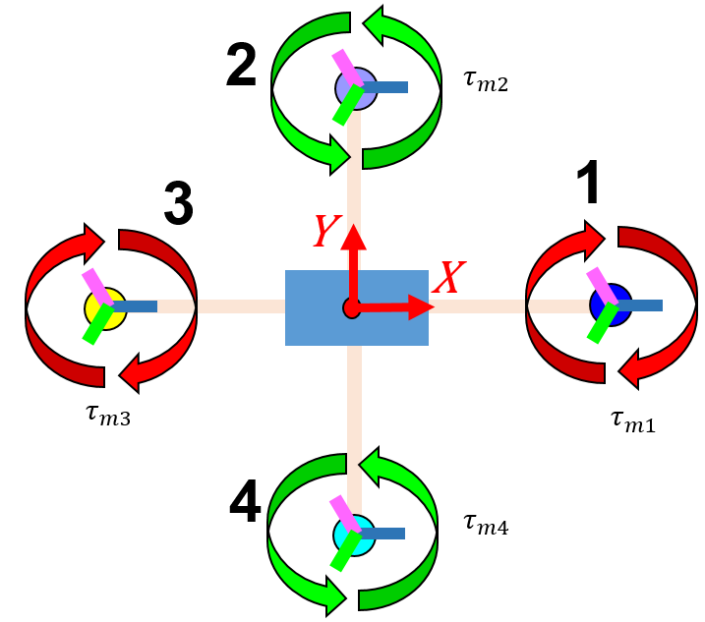


Does it fly ?



Today's Agenda:

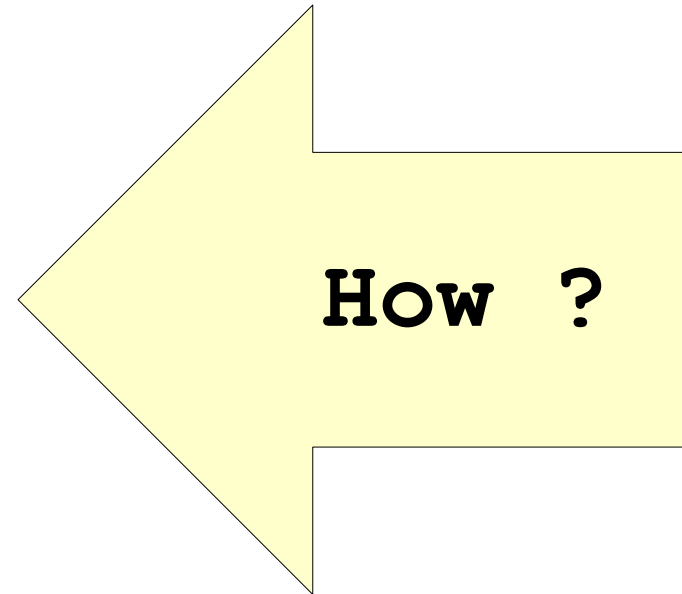
- Review Student learning styles
 - Surface learning versus Deep learning
- The MATLAB Technical Computing Environment
 - How can it support/encourage Deep Learning?
- Where can you find teaching resources ?
- Q/A
 - How can you download ALL of the demonstrations shown today ?



Student Learning styles - Surface versus Deep

Deep approach:

- A desire to understand
- Will take ownership of learning.
- Wants to Link concepts and apply to problem solving.
- Regards learning as a pleasant thing to do



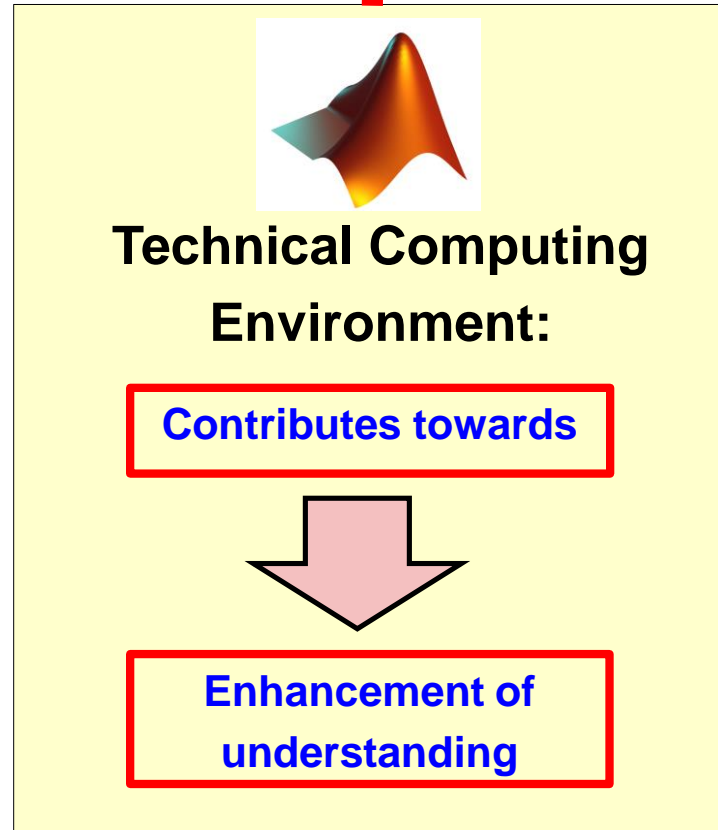
Surface approach

- Learning to pass an exam
- Rote learning
- Disinterest in seeking connections that link concepts
- Learning is UNpleasant

Fostering a Deep Learning approach:

Deep Learning:

- A desire to **understand**
- Will take ownership of learning.
- Wants to Link concepts and apply to problem solving.
- Regards learning as a pleasant thing to do



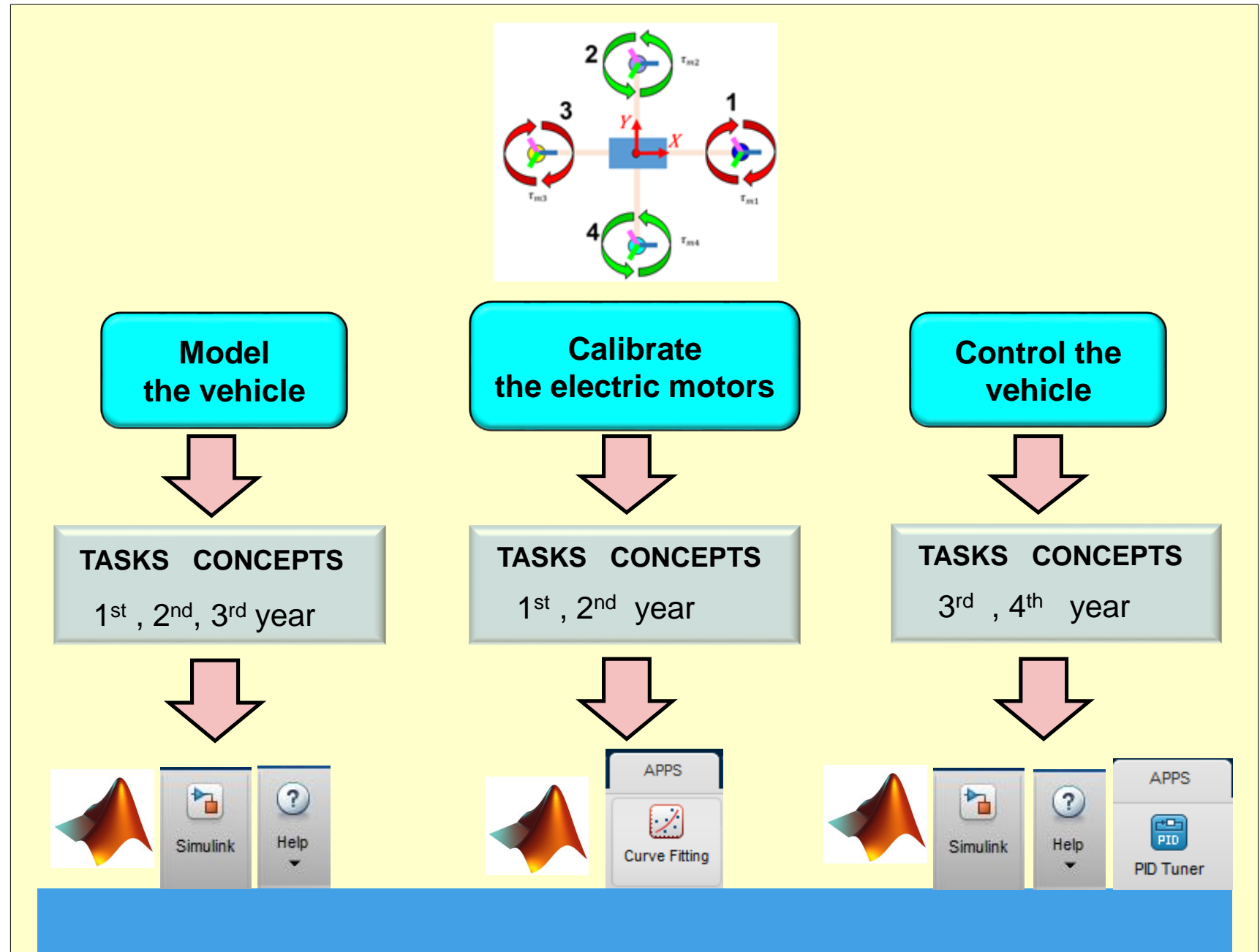
Enhancement of Understanding

- Decompose BIG problems into several smaller problems.
- Provide choices on how to solve.
- Build upon existing skills and experiences
- Provide self serve support

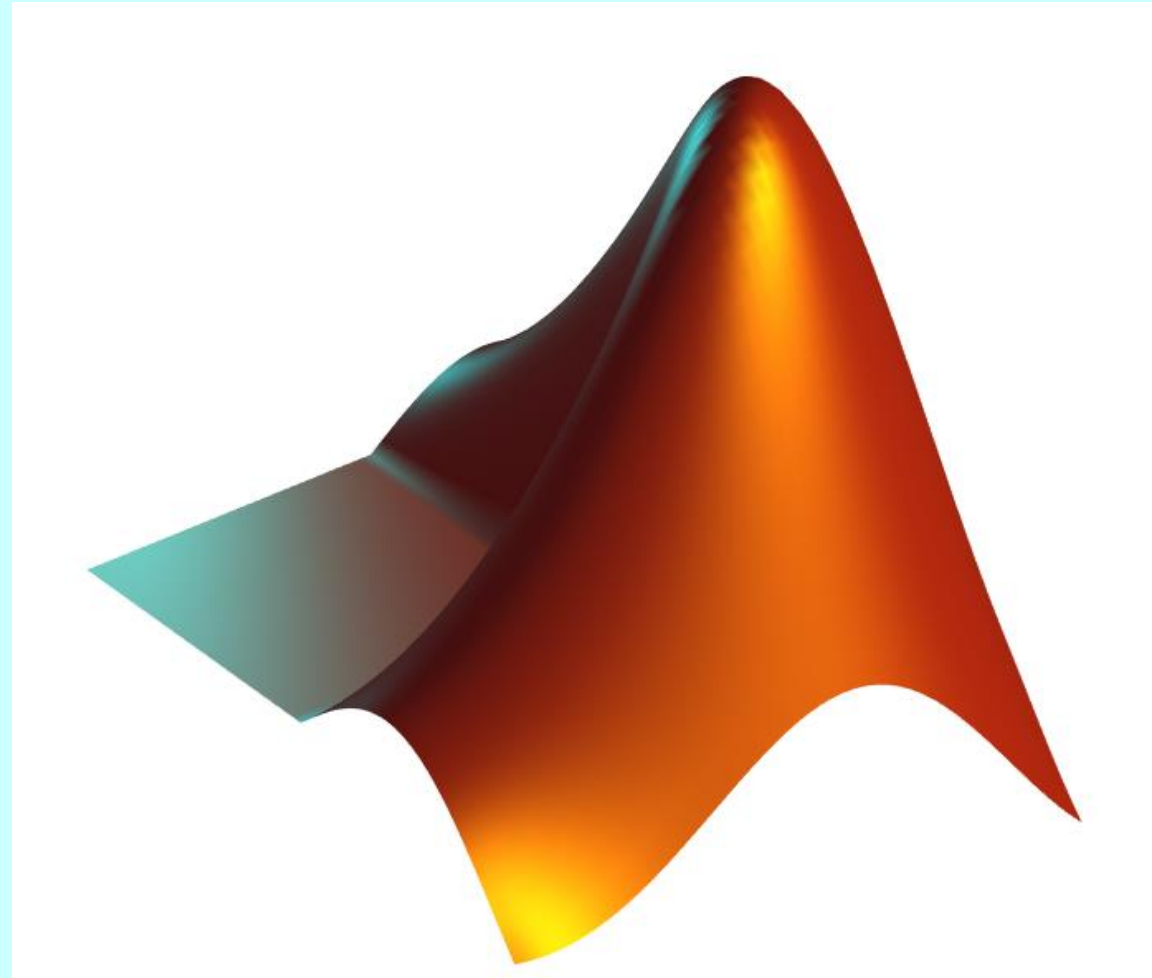
Quadcopter case study

Enhancement Of Understanding:

- Decompose 1 BIG problem into several smaller problems.
- Build upon existing skills and experiences
- Choices on how to solve
- Provide self serve support



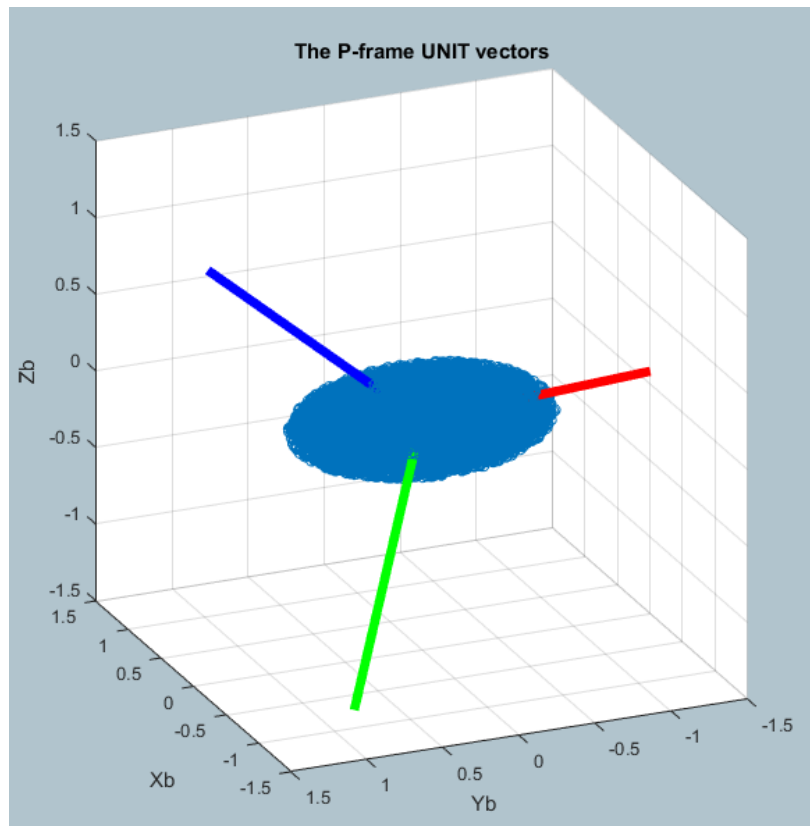
Demo
these
tasks



R2016b

Task: Principal moments of Inertia

$${}^P L = {}^P I \times {}^P \omega \quad \text{where} \quad {}^P I = \begin{pmatrix} I_1 & 0 & 0 \\ 0 & I_2 & 0 \\ 0 & 0 & I_3 \end{pmatrix}$$



 **Live Script**

 `bh_task_principal_I.mlx`



Help

```
>> doc eig  
>> doc Linear Algebra
```

Free MATLAB Courseware

[Numerical Computing with MATLAB](#)



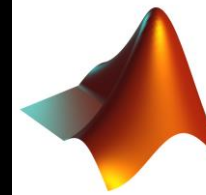
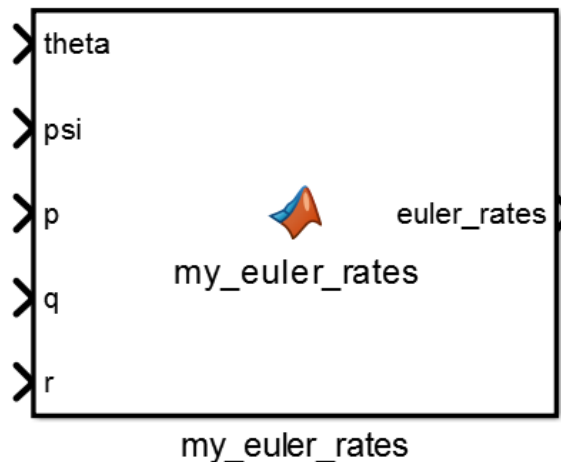
[Applied Numerical Methods with MATLAB](#)

Task: Passive Rotations and Euler rates


```
euler_rates = A \ [p; q; r];  
euler_rates = simplify(euler_rates)
```

euler_rates =

$$\begin{pmatrix} \frac{r \cos(\psi) + q \sin(\psi)}{\cos(\theta)} \\ q \cos(\psi) - r \sin(\psi) \\ \frac{p \cos(\theta) + r \cos(\psi) \sin(\theta) + q \sin(\psi) \sin(\theta)}{\cos(\theta)} \end{pmatrix}$$



Live Script

 bh_task_explore_euler_rates_CONCEPT.mlx



Help

```
>> doc live scripts  
>> doc matlabFunction  
>> doc matlabFunctionBlock
```

Free MATLAB Courseware

[Introduction to MATLAB](#)

[Aeronautical Systems-Guidance and Control](#)

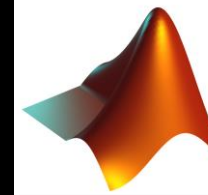
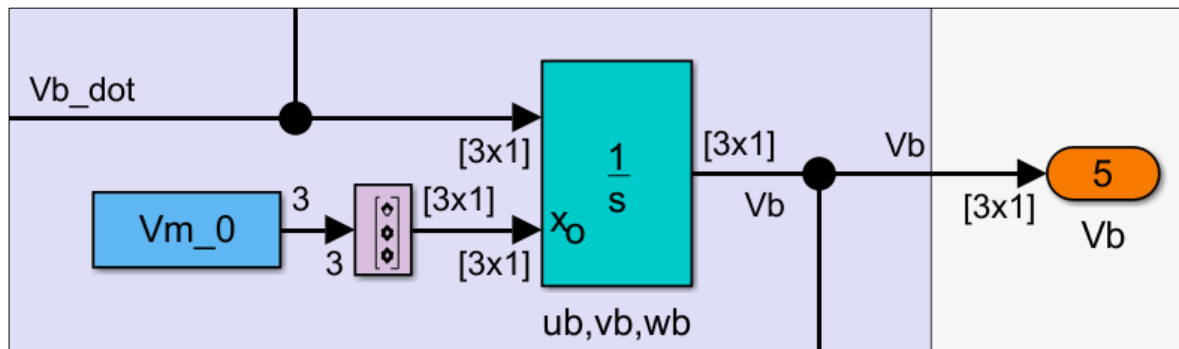
Task: Solving ODEs

$${}^B F = m. ({}^B \dot{V} + {}^B \omega \times {}^B V)$$

$${}^B M = {}^B I. {}^B \dot{\omega} + {}^B \omega \times ({}^B I. {}^B \omega)$$

```
% F = m*(vDOT + w_x_v)
vDOT = F/m - cross(w,vB);

% M = I*wDOT + w_x_(I*w)
wDOT = inv(I) * (M - cross(w, I*w));
```



Live Script

bh_task_integrate_6dof_MATLAB.mlx



Help

```
>> doc ODE solver
>> doc ode45
>> doc table
>> doc readtable
```

Free MATLAB Courseware

[Numerical Computing with MATLAB](#)



[Applied Numerical Methods with MATLAB](#)

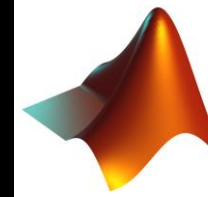
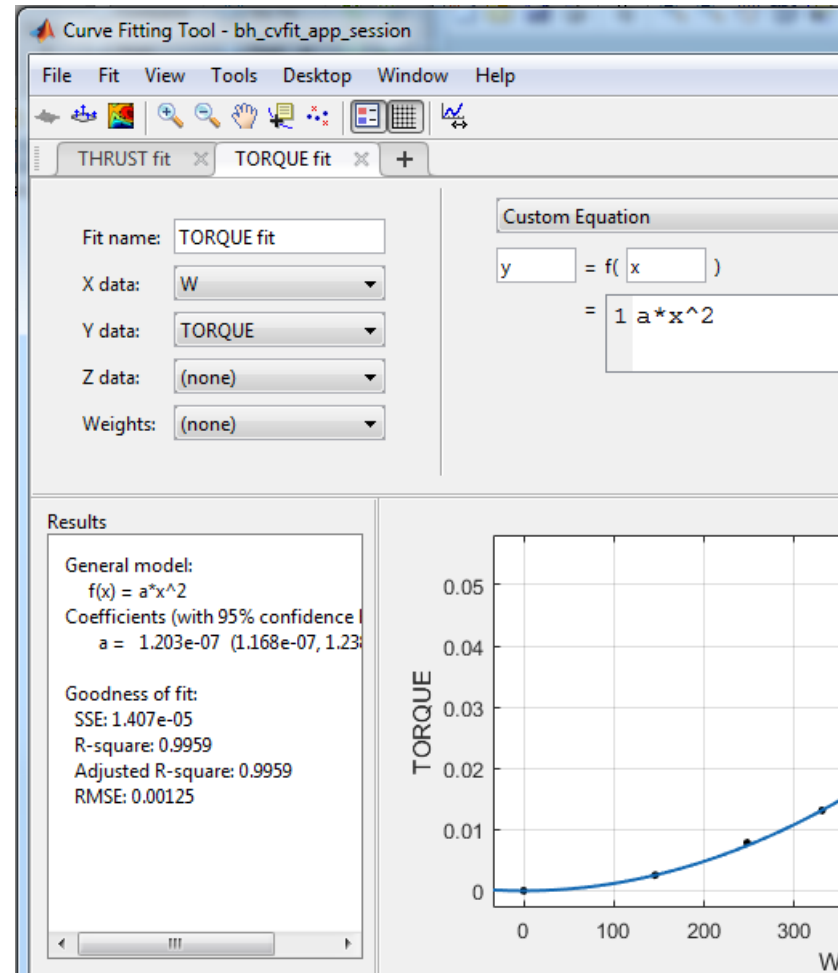
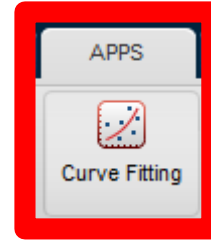
[Differential Equations and Linear Algebra](#)



Task: calibrate Thrust,Torque with speed

$$THRUST = k_F \times \omega^2$$
$$TORQUE = k_M \times \omega^2$$

$$A = W.^2;$$
$$b = TORQUE;$$
$$kM = A \backslash b$$



Live Script

bh_task_do_F_and_TQ_calibration.mlx



Help

```
>> doc curve fitting
>> doc cvfit
>> doc linear equations
>> doc readtable
```

Free MATLAB Courseware

[Numerical Computing with MATLAB](#)

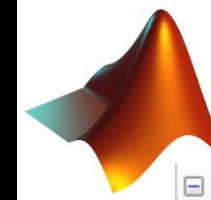
[Engineering Models I](#)

[Engineering Models II](#)

[Introduction to Engineering Analysis](#)



Task: Linearise and Control design



Live Script

bh_task_find_trim_and_linearise.mlx
 bh_task_siso_control_design.mlx



Help

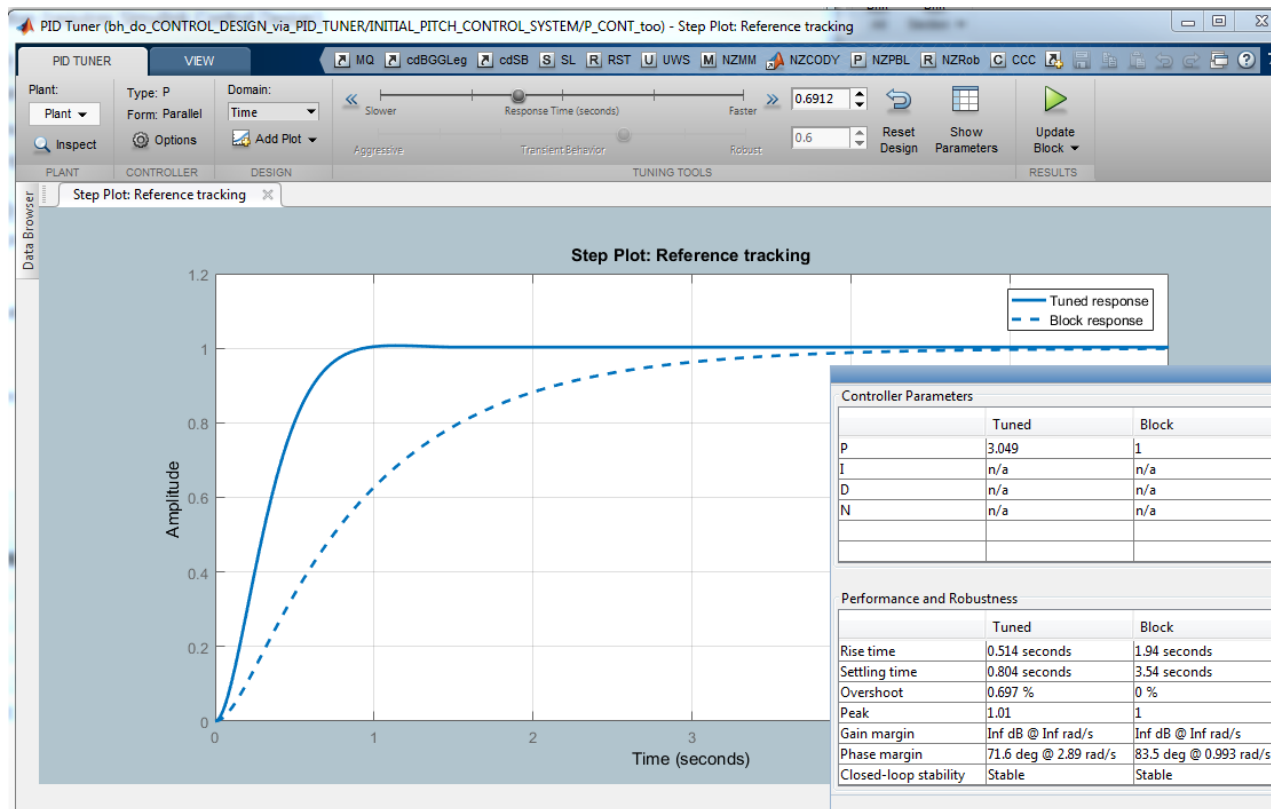
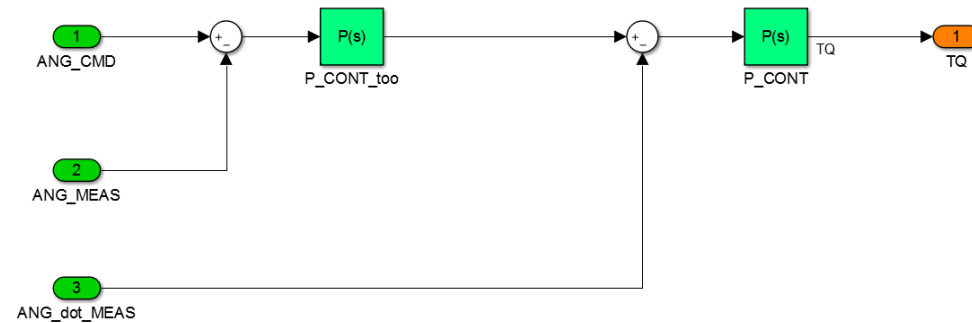
```
>> doc findop  
>> doc linearize  
>> doc pidTuner  
>> doc controlSystemDesigner
```

Free MATLAB Courseware

[Control Tutorials for MATLAB and Simulink](#)

[Aeronautical Systems-Guidance and Control](#)

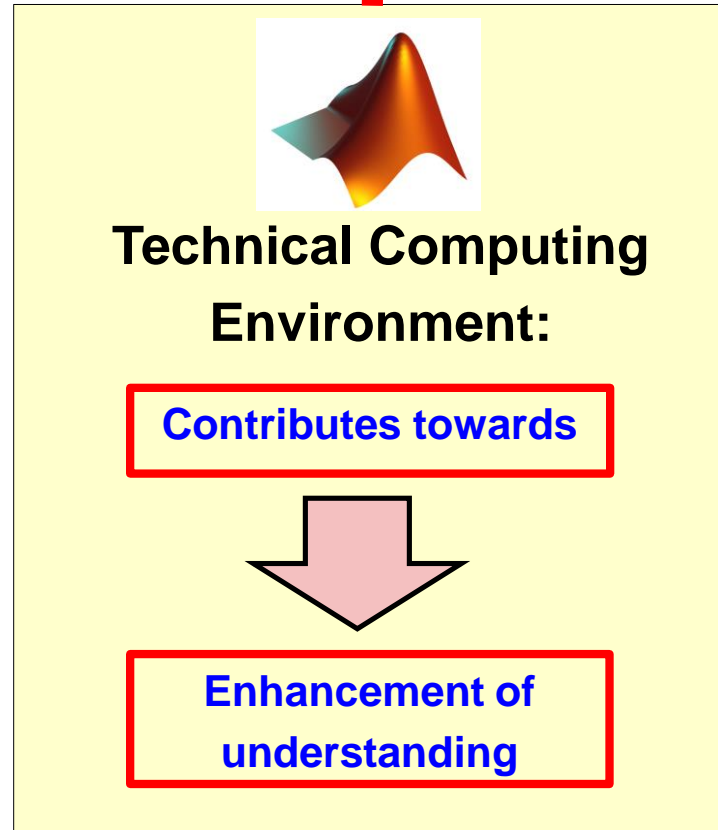
[Embedded Control and Mechatronics](#)



Fostering a Deep Learning approach:

Deep Learning:

- A desire to **understand**
- Will take ownership of learning.
- Wants to Link concepts and apply to problem solving.
- Regards learning as a pleasant thing to do



Enhancement of Understanding

- Decompose BIG problems into several smaller problems.
- Provide choices on how to solve.
- Build upon existing skills and experiences
- Provide self serve support

Teaching and Learning Resources.

MATLAB Courseware

Search MathWorks.com

Educator Home | Classroom Resources | Hardware Support | License Options | Research

Mathematics

Applied Numerical Methods with MATLAB
Professor Steven C. Chapra
Tufts University

Differential Equations and Linear Algebra
Professor Gilbert Strang
Massachusetts Institute of Technology
Cleve Moler
MathWorks

Numerical Computing with MATLAB
Cleve Moler
MathWorks

Related Books Mathematics

MATLAB Courseware

Search MathWorks.com

Educator Home | Classroom Resources | Hardware Support | License Options | Research

Earth, Atmospheric, and Ocean Sciences

Geoscience with MATLAB
from SERC@Carleton

Related Books Earth Sciences

MATLAB Courseware

Search MathWorks.com

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

Discovery-Based Learning
Professor Steve McKnight
Professor Gilead Tadmor
Northeastern University

Engineering Problem Solving
Professor Stanley Hsu
Professor Rajeevan Amirtharajah
Professor Andre Knoesen
University of California, Davis

Introduction to Engineering Analysis
Professor Ivan V. Bajic
Professor Fabio Campi
et al.

<http://www.mathworks.com/academia/courseware>

Curriculum materials:

MATLAB Courseware

Cody Coursework™

Online automated grading system for
MATLAB assignments

<http://mathworks.com/help/coursework/cody-coursework-for-instructors.html>

- Create online private courses and assignments
- Students **execute MATLAB code on the web**
- Control the visibility of the test suites from students.
- Visualize solution results using MATLAB graphics
- Download all student attempts and **report on grading data**

Problems

1b:: Represent a piecewise linear ...	<div><div></div></div>
2b:: Derive the ANALYTICAL soluti...	<div><div></div></div>
2e:: Calculate the Frequency Res...	<div><div></div></div>
2f_1:: Derive the ANALYTICAL sol...	<div><div></div></div>
2f_2:: Calculate the unit STEP res...	<div><div></div></div>

Create Report : Assignment 1

Assignment 1

- ☒ Last best solutions submitted by due date(05 Jun 2015 2:00 PM UTC)
- ☐ Last best solution as of today
- ☐ All solutions

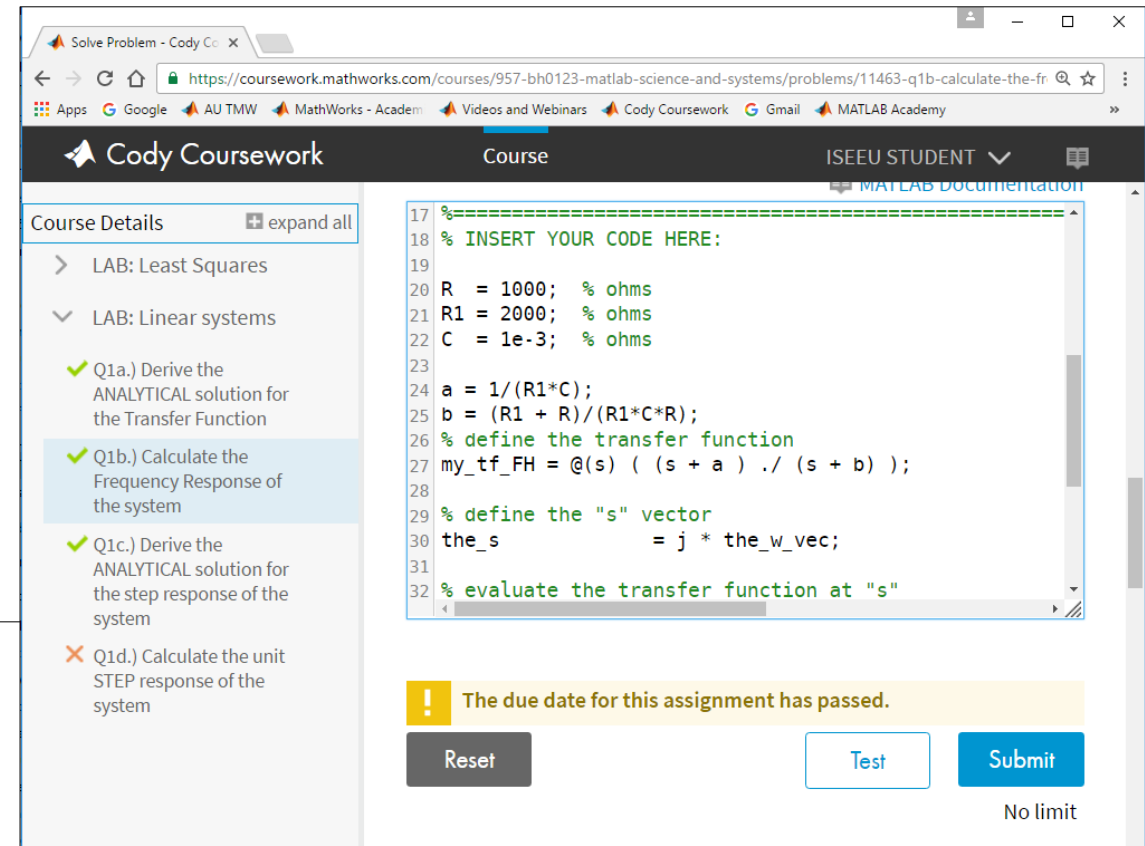
Report Format CSV

CSV

Excel

Cancel

Create



Solve Problem - Cody Co X

<https://coursework.mathworks.com/courses/957-bh0123-matlab-science-and-systems/problems/11463-q1b-calculate-the-fr>

Apps Google AU TMW MathWorks - Academ Videos and Webinars Cody Coursework Gmail MATLAB Academy

Cody Coursework Course ISEEU STUDENT

Course Details expand all

- LAB: Least Squares
- LAB: Linear systems
 - ✓ Q1a.) Derive the ANALYTICAL solution for the Transfer Function
 - ✓ Q1b.) Calculate the Frequency Response of the system
 - ✓ Q1c.) Derive the ANALYTICAL solution for the step response of the system
 - ✗ Q1d.) Calculate the unit STEP response of the system

```

17 %=====
18 % INSERT YOUR CODE HERE:
19
20 R = 1000; % ohms
21 R1 = 2000; % ohms
22 C = 1e-3; % ohms
23
24 a = 1/(R1*C);
25 b = (R1 + R)/(R1*C*R);
26 % define the transfer function
27 my_tf_FH = @(s) ( (s + a) ./ (s + b) );
28
29 % define the "s" vector
30 the_s = j * the_w_vec;
31
32 % evaluate the transfer function at "s"

```

! The due date for this assignment has passed.

Reset Test Submit

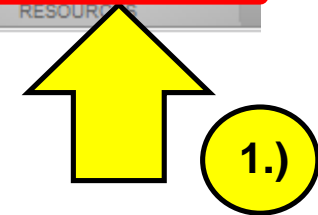
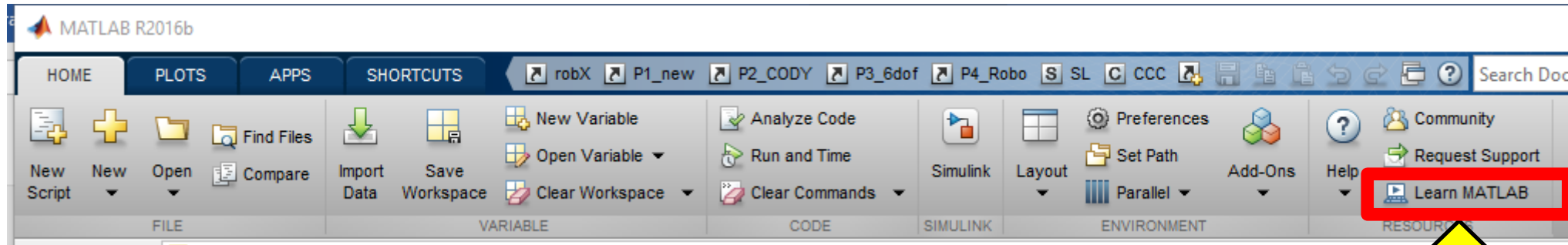
No limit

The 1st Stop: For students

For Students



- **MATLAB ACADEMY (the portal)**
 - Access a free interactive training course called **MATLAB Onramp**



2.)

Launch the *FREE*
course called
MATLAB OnRamp

The 1st Stop: For students

For Students



- **MATLAB Onramp**
 - Provided through your web browser
 - Introduction of programming concepts
 - Students answer questions ... and get IMMEDIATE feedback

The screenshot displays the MATLAB Onramp web interface. The browser address bar shows the URL `https://matlabacademy.mathworks.com/R2016a/portal.html`. The page header includes the MATLAB academy logo, the title "MATLAB Onramp" with a "3% complete" progress indicator, and the user name "Bradley Horton". The main content area is titled "6.1 Performing Array Operations on Vectors" and contains "Task 1".

Task 1

Info: MATLAB is designed to work naturally with arrays. For example, you can add a scalar value to all the elements of an array.

```
>> y = x + 2
```

Try adding `1` to each element of `v1` and store the result in a variable named `r`.

[Hint](#) [See Solution](#)

Task 2
Task 3
Task 4
Task 5
Task 6

The central workspace area shows the following MATLAB code:

```
>> load datafile
>> density = data(:,2);
>> v1 = data(:,3);
>> v2 = data(:,4);

Task 1
>>
```

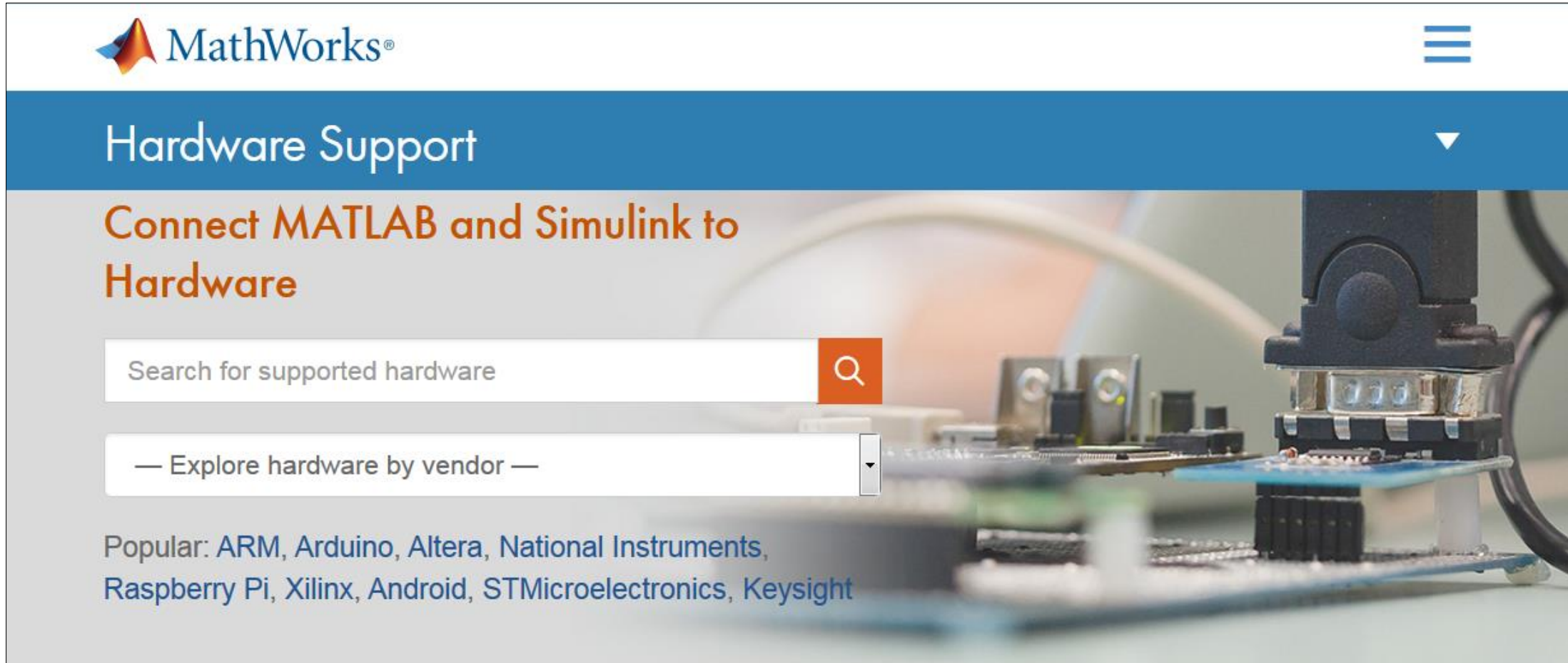
Overlaid on the workspace area are two text boxes: a yellow box with the word "Free" and a pink box with the text "Interactive tutorial".

On the right side, the "WORKSPACE" panel displays the following table:

Name	Value	Size	Class
d...	7x4 ...	7x4	double
d...	[0.5... 7x1	7x1	double
v1	[4.0... 7x1	7x1	double
v2	[0.5... 7x1	7x1	double

Connecting to Hardware

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



The screenshot shows the MathWorks Hardware Support page. At the top is the MathWorks logo and a hamburger menu icon. Below this is a blue header with the text "Hardware Support" and a downward arrow. The main content area has a background image of a circuit board being tested by a probe. The text "Connect MATLAB and Simulink to Hardware" is prominently displayed in orange. Below this is a search bar with the placeholder text "Search for supported hardware" and a magnifying glass icon. Under the search bar is a dropdown menu with the text "— Explore hardware by vendor —". At the bottom, a list of popular hardware vendors is shown: "Popular: ARM, Arduino, Altera, National Instruments, Raspberry Pi, Xilinx, Android, STMicroelectronics, Keysight".

MathWorks®

Hardware Support

Connect MATLAB and Simulink to Hardware

Search for supported hardware

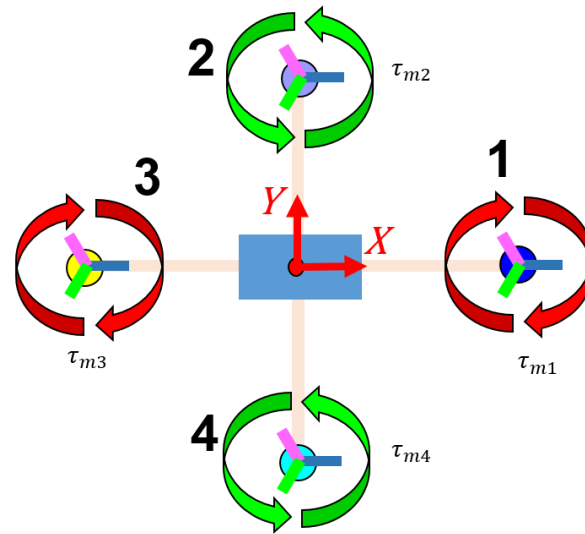
— Explore hardware by vendor —

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

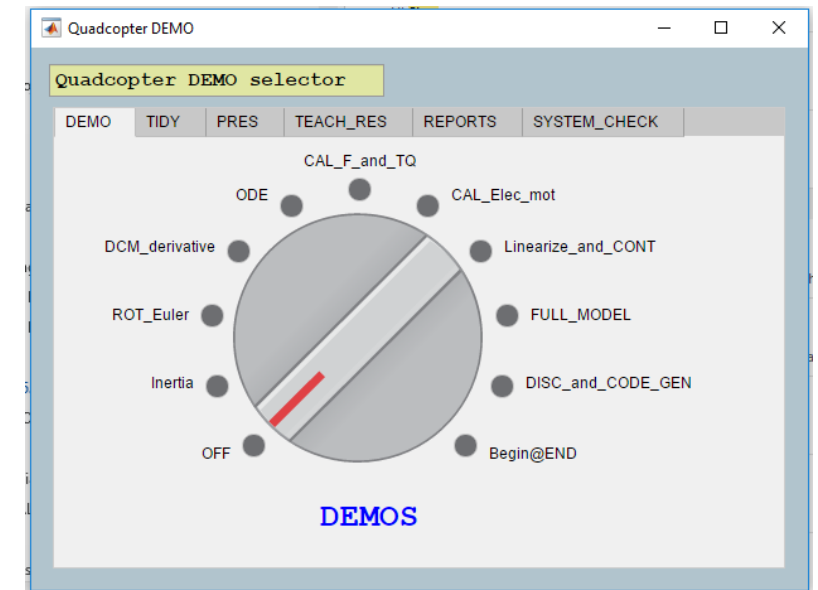
Wrap up

Q/A:

- Are there some questions please ?
- Download the examples that you saw today ... and more that you didn't !



R2016b



>> bh_startup_6dof