UNIVERSITY of WASHINGTON

November 13–14, 2024 | Online

Asynchronous Engineering Instruction and Teaching Using MATLAB and Simulink

Christopher Lum, University of Washington

MATLAB EXPO

https://www.youtube.com/@ChristopherLum

www.linkedin.com/in/christopherlum3

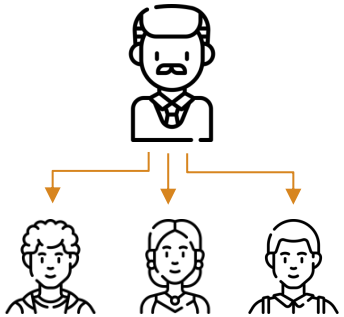
Outline

1. What is asynchronous teaching ?
2. Examples of classes at UW.
3. MathWorks tools in industry.
4. How to develop an asynchronous curriculum.
5. Teaching Impact.

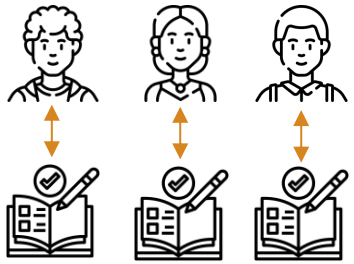
Synchronous vs. Asynchronous Instruction

Linear Progression

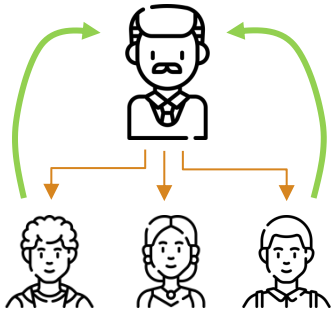
Lecture (4 hr)



Homework (10 hr)

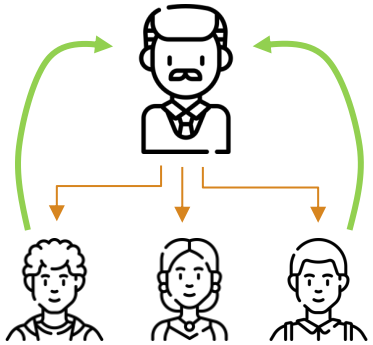


Office Hours (1 hr)

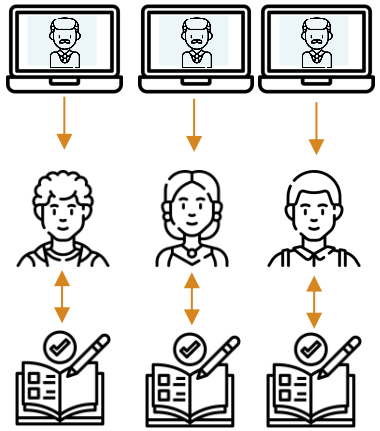


Quasi-Linear Progression

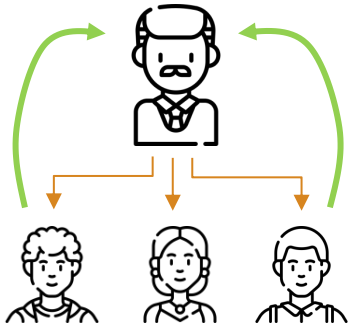
Interactive Meeting (1 hr)



Lecture and Homework (13 hr)



Office Hours (1 hr)

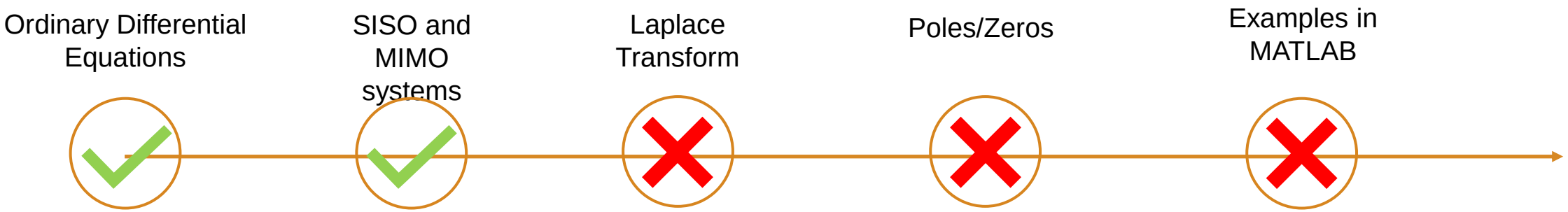


- **Synchronous**
  - Class meets synchronously on a set schedule. Class time is spent:
    - Instructor giving lecture.
    - Students asking questions*.
- **Asynchronous**
  - Instructor develops instructional artifacts (videos, notes, code, etc.) and assigns modules.
  - Class meets synchronously on a set schedule. Class time is spent with:
    - Instructor giving outline/roadmap of current week's content.
    - Answering student questions on previous week concepts.
- **Both**
  - Students work on homework on their own schedule.
  - Students meet with instructor and/or TAs at set/scheduled office hours.

Learning Breakdowns

- Learning breakdowns occur when a concept is not understood.
- In a synchronous environment, if student experiences a learning breakdown, this affects subsequent topic/concepts.

Transfer Functions



"What any person in the world can learn, almost all persons can learn if provided with appropriate prior and current conditions of learning"

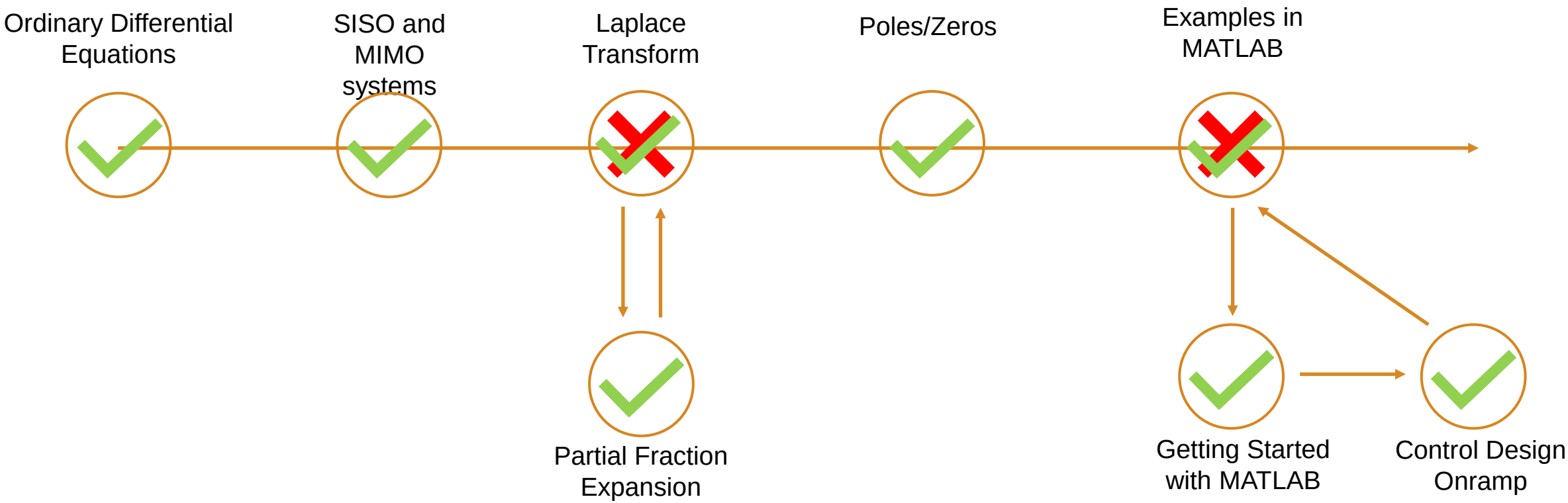
– **Benjamin Bloom**

The Era of Online Learning | Niema Moshiri | TEDxUCSD https://youtu.be/5JKgUoY9pTg?si=PxtXF_LEXs7Hxvc3

Learning Detours

- **In an asynchronous environment, when student experiences a learning breakdown, they can pause their learning experience and perform independent research/learning to bring them up to speed.**

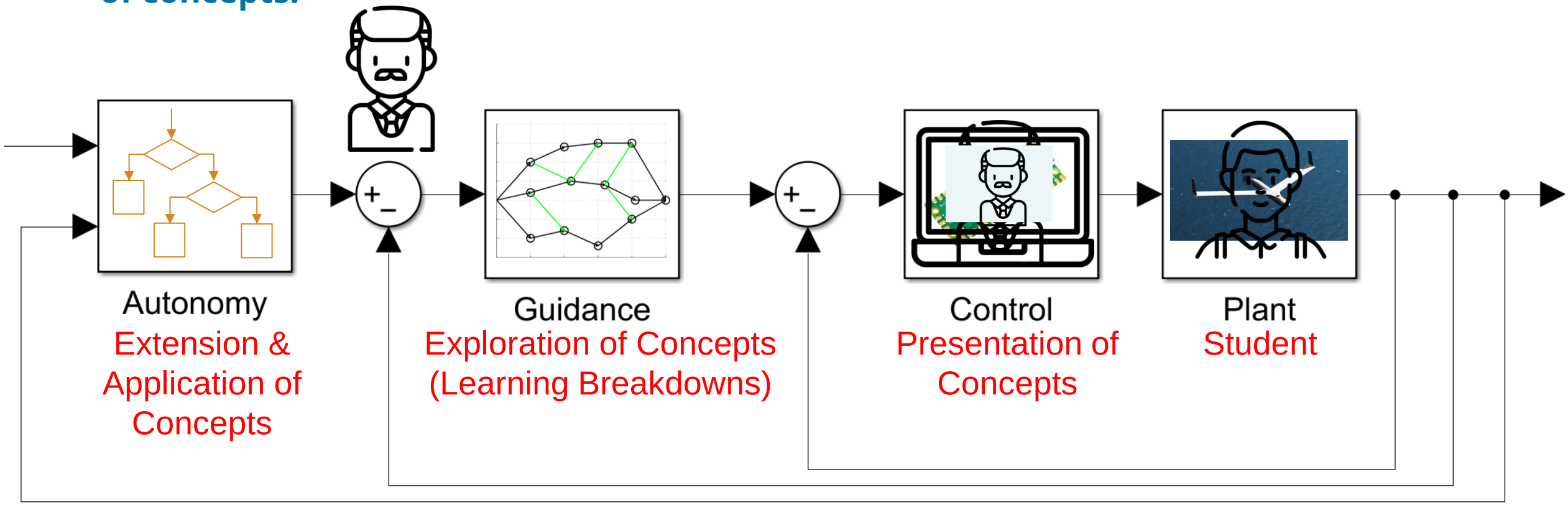
Transfer Functions



The Era of Online Learning | Niema Moshiri | TEDxUCSD https://youtu.be/5JKgUoY9pTg?si=PxtXF_LEXs7Hxvc3

Instructors and Students in a Feedback Loop

- Inner loop control is a fairly mature technology. Expertise/supervision is needed at guidance and autonomy levels.
- SME resources in learning environment should be applied to exploration, extension, and application of concepts, not presentation of concepts.



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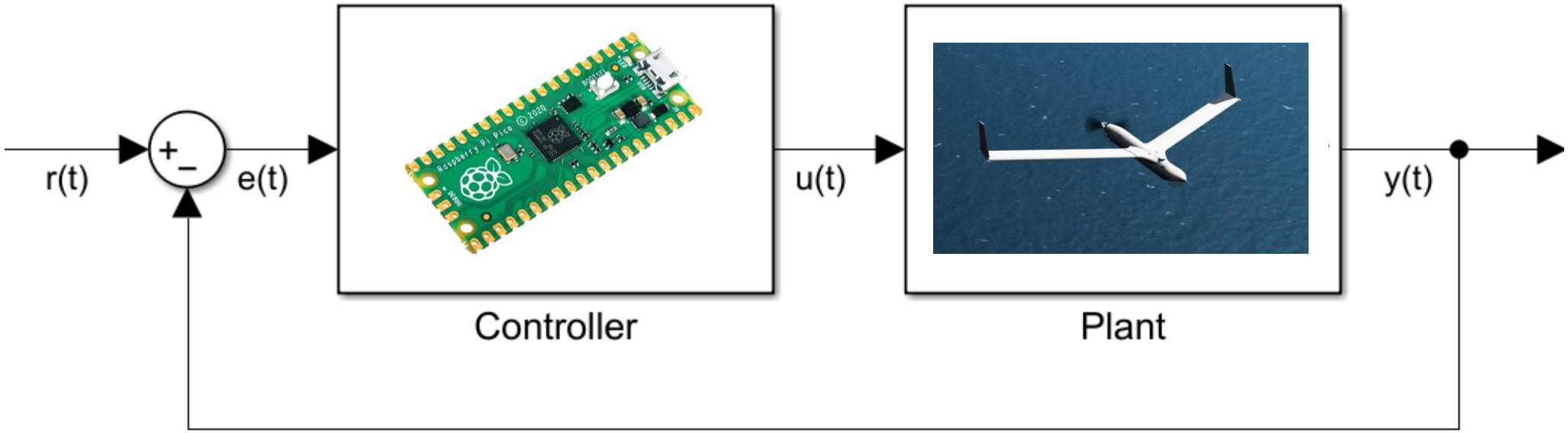
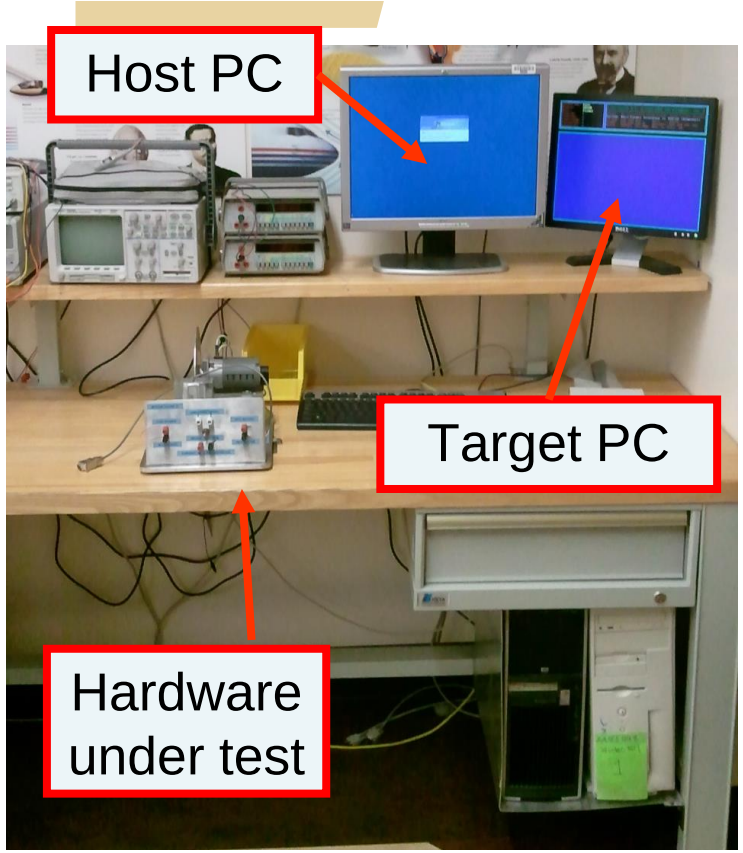
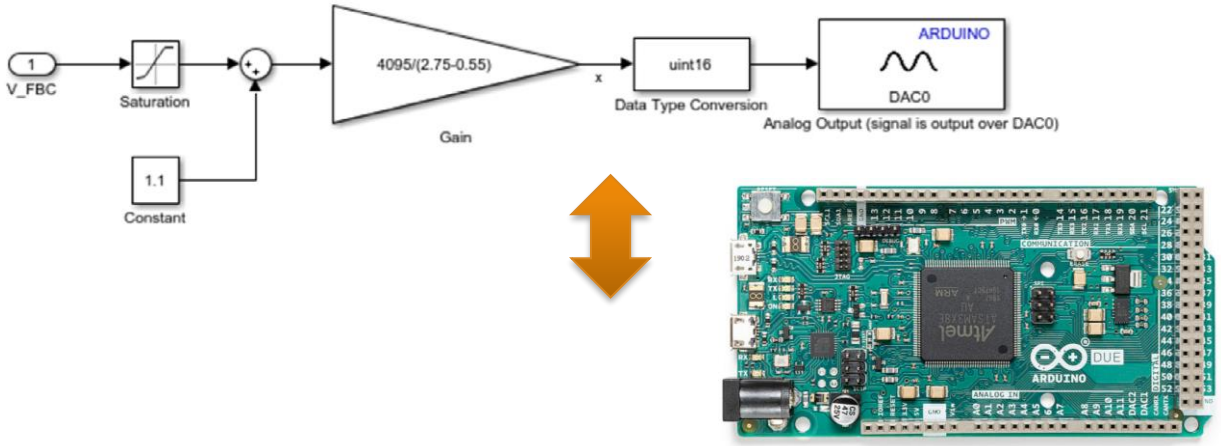
AA448 – Control System Sensors and Actuators

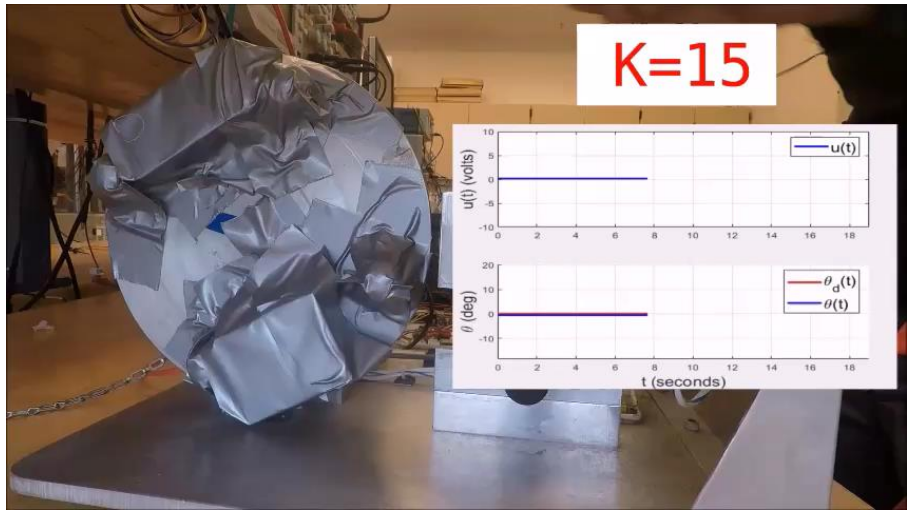
- 2nd class in controls-focused curriculum.
- Laboratory-focused class that gives students an opportunity to apply theoretical control concepts to actual hardware and obtain practical implementation experience.



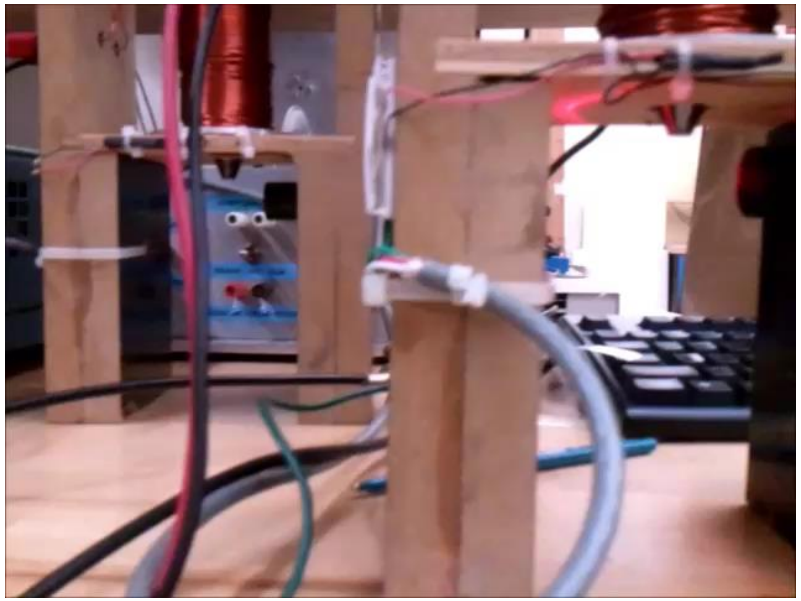
AA448 – Control System Sensors and Actuators







Modeling and Control of a DC Motor



Modeling and Control of a Magnetic Levitator

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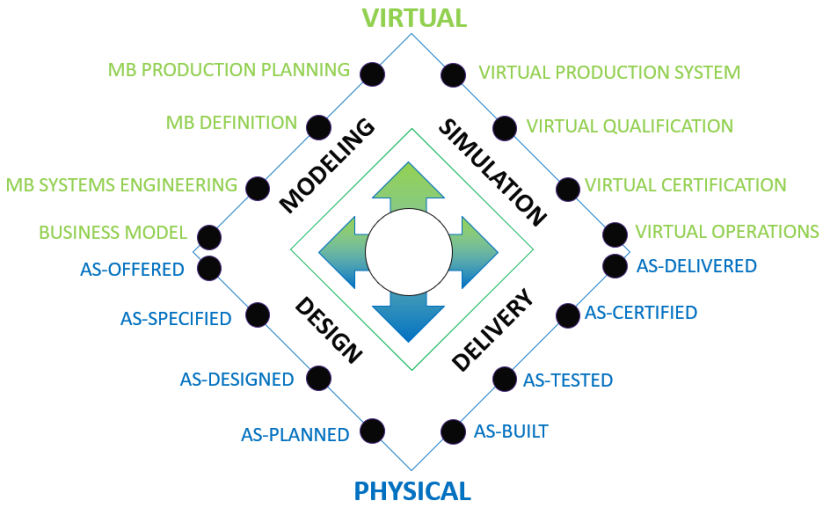
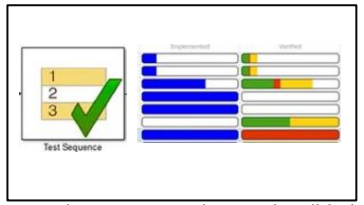
Model Based Engineering

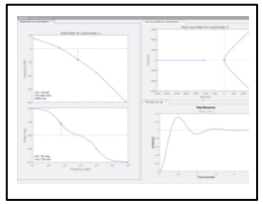
> **MathWorks products are used by industry to enable MBE and digital workflows.**

Physical System

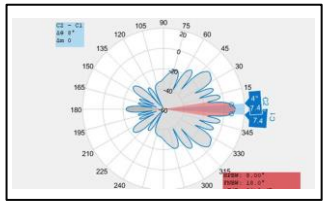




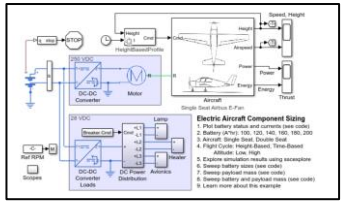
Requirements, Testing, and Validation



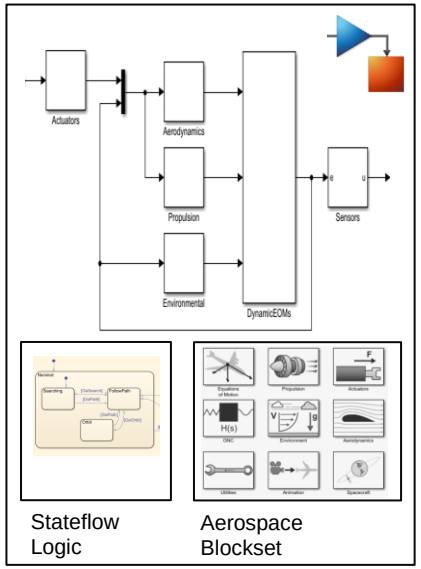
Control Design and Analysis



Antenna Design



Simscape for Multidomain Modeling

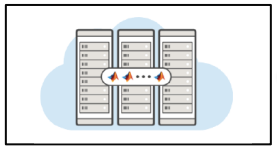


Simulink Integration and Simulation

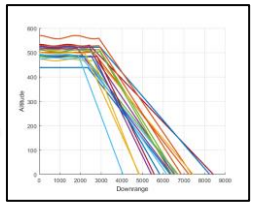
Stateflow Logic

Aerospace Blockset

Visualization (Simulink 3D Animation)



Parallel Computing



Monte Carlo Analysis

Simulink Coder (Code Generation)

Integration into Flight Software

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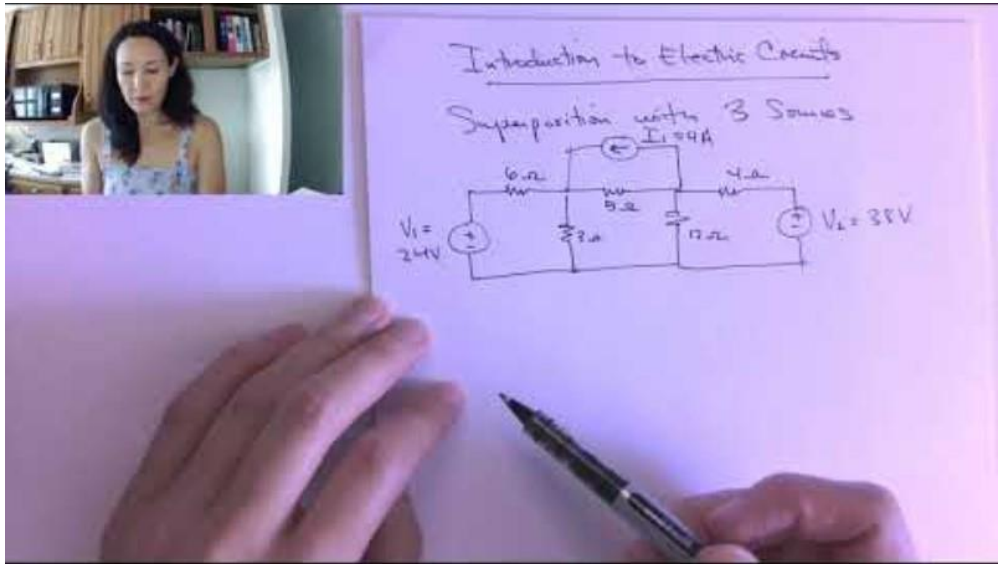
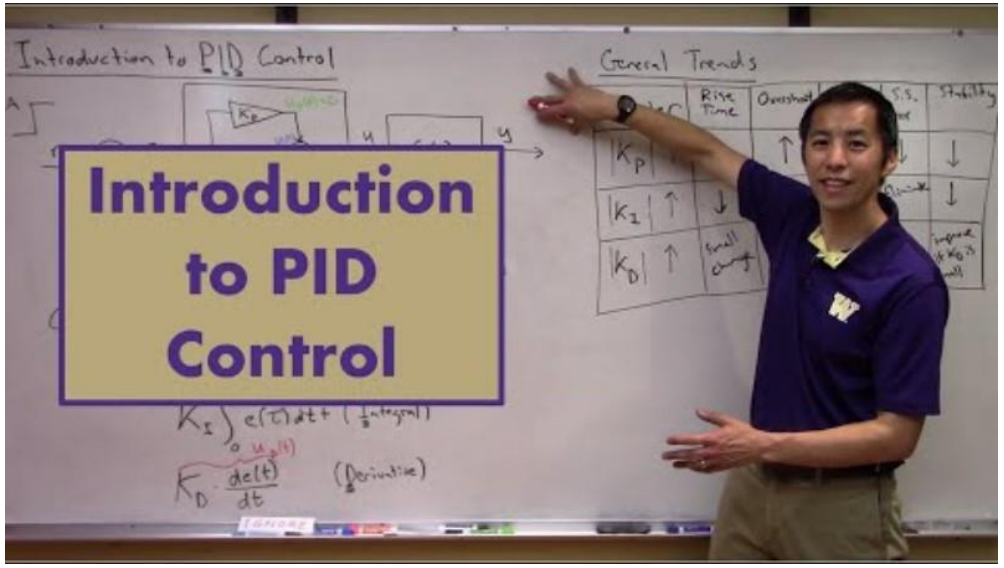
Filming Classes/Lectures/Modules

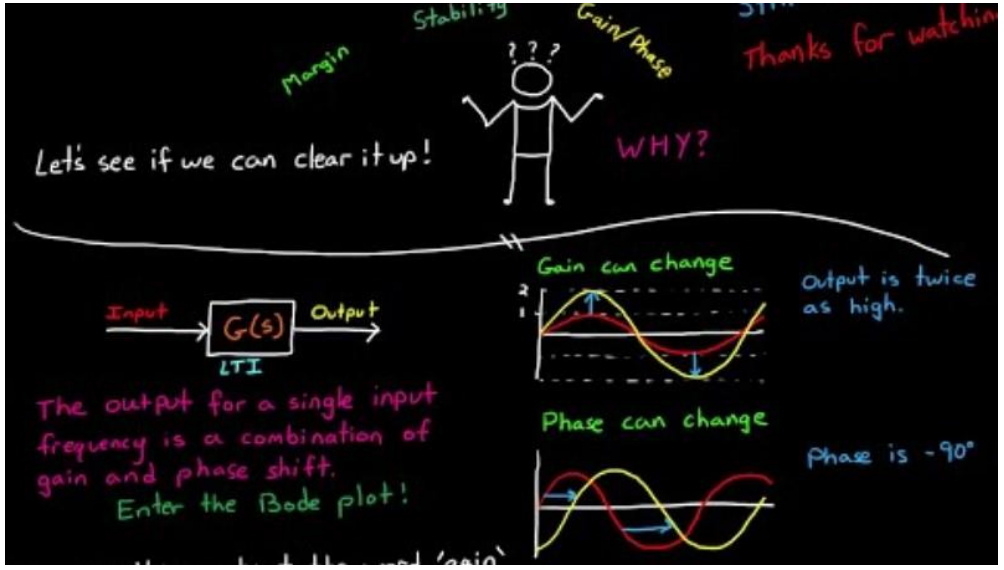
EE Prof Lady

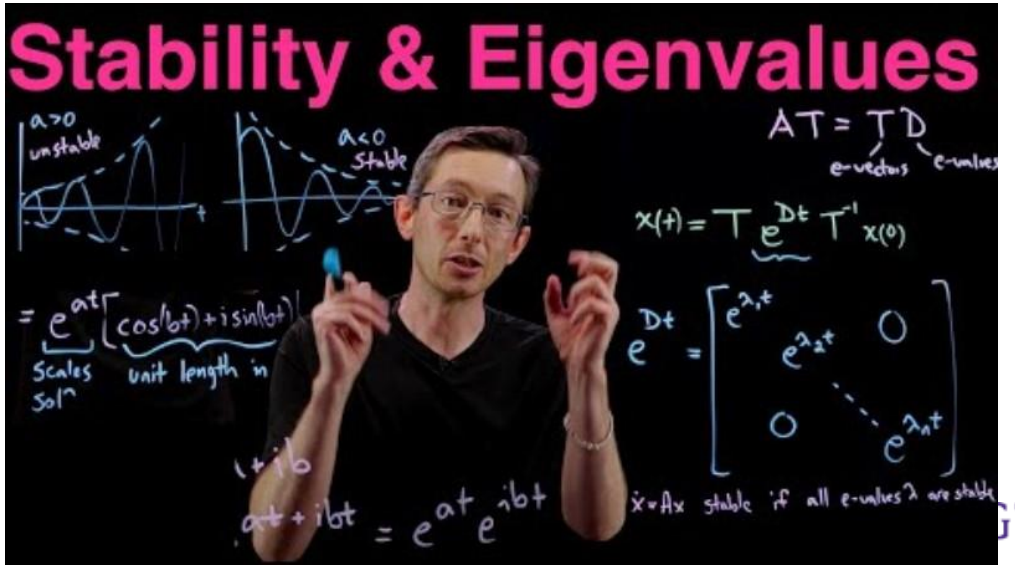




Christopher Lum

Brian Douglas

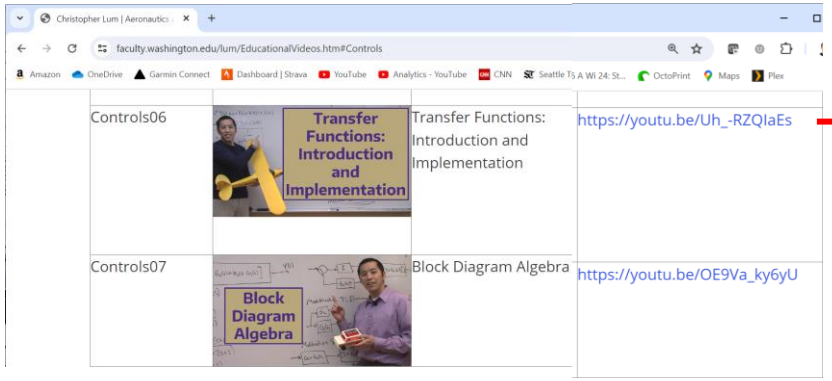




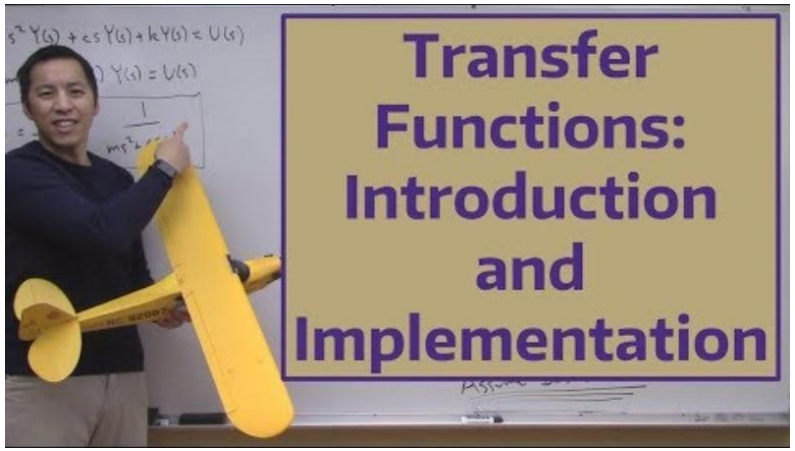
Steve Brunton

Distribution

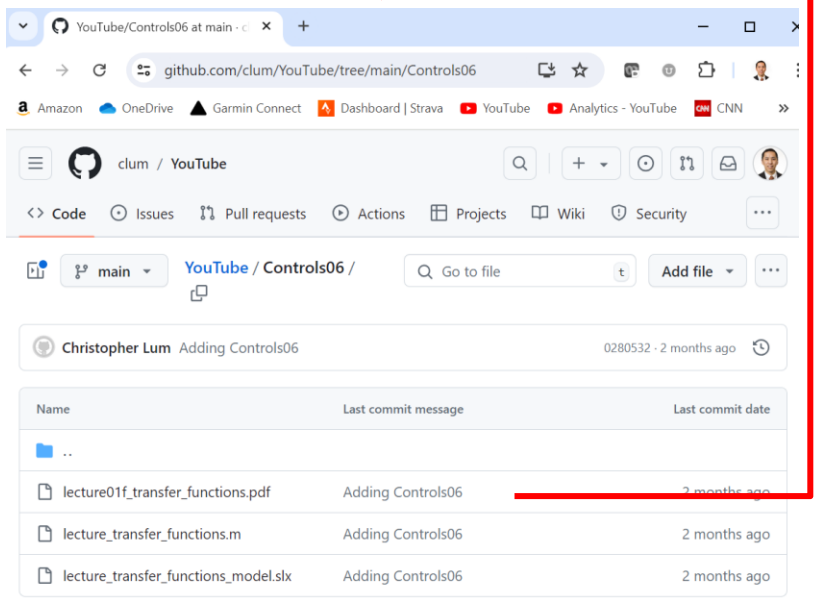
- Class materials are entirely digital (lecture notes, homework, code, etc.)
- Videos produced by instructor and posted on YouTube
- Videos are organized into modules (for UW classes) and playlists (for general public consumption).



https://faculty.washington.edu/lum/EducationalVideos.htm



https://youtu.be/Uh_-RZQIaEs



https://github.com/clum/YouTube/tree/main/Controls06

Christopher Lum
lum@uw.edu

Lecture 01f
Transfer Functions: Introduction and Implementation

Lecture is on YouTube

The YouTube video entitled 'Transfer Functions: Introduction and Implementation' that covers this lecture is located at https://youtu.be/Uh_-RZQIaEs.

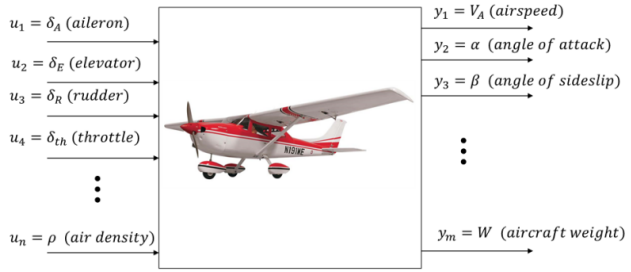
Transfer Functions

So far in the class, we have only studied systems that response to initial conditions. The transfer function approach will help us study how a system responds to various inputs.

When speaking with control engineers casually, you may hear a transfer function referred to as a black box model that relates a specific input to a specific output.

Example: Aircraft

Consider and aircraft



Aircraft Model

Every video has an accompanying set of digital lecture notes, code, models, etc.

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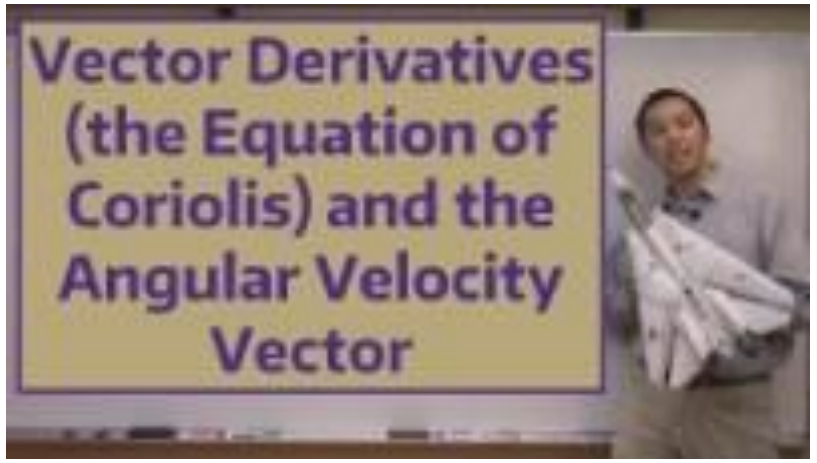
Benefits to Students

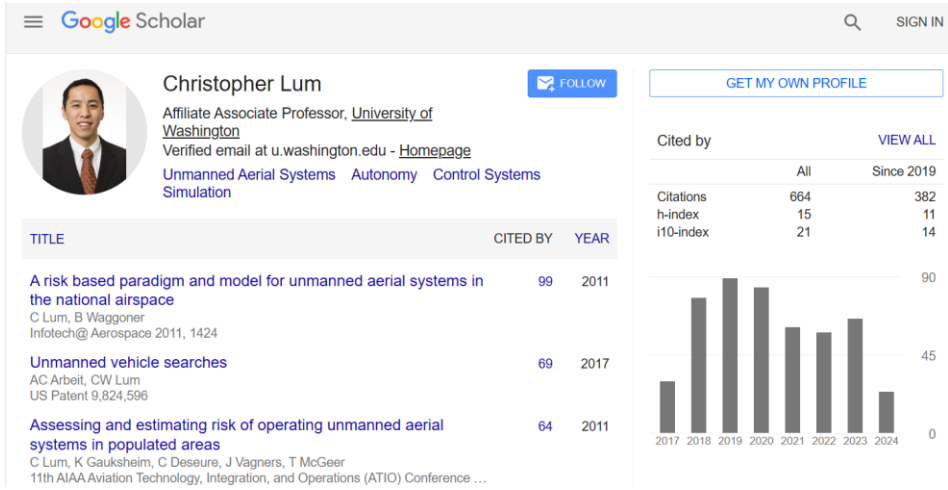
- **Better lecture experience for students**
  - **Ability to integrate advanced visualizations, media, etc.**
  - **More efficient delivery of content (increased knowledge/minute).**
  - **Closed captioning.**
  - **Ability to speed up and slow down content.**
  - **Embedded forum to discuss ideas/concepts.**



C Lum, S Gardner, C Jordan, M Dunbabin, “Expanding Diversity in STEM: Developing International Education and Research Partnerships in a Global Society” Proceedings of the 123rd American Society for Engineering Education (ASEE) 2016

Teaching Impact

- Research impact is measured by various metrics (h-index, i10-index, etc.). What about teaching?
- How do you create a lasting teaching legacy?
- Research undoubtably advances the frontier of science and engineering but teaching inspires the next generation of innovators.
- How do students access information in the modern age? They typically go to the internet (Google, Wikipedia, and YouTube).



YouTube as a Platform

> **Detailed statistics and data associated with content delivery.**

Param	Value
# Videos	369
Views	10.1M
Watch time	82.9 years
Subscribers	67.5k

Conclusions

- **MathWorks accelerates the pace of science and engineering in both academic and industry environments.**
- **Digital tools help with learning and implementing engineering concepts.**
- **Asynchronous content development and delivery benefits a wide range of stakeholders (both consumers and creators).**

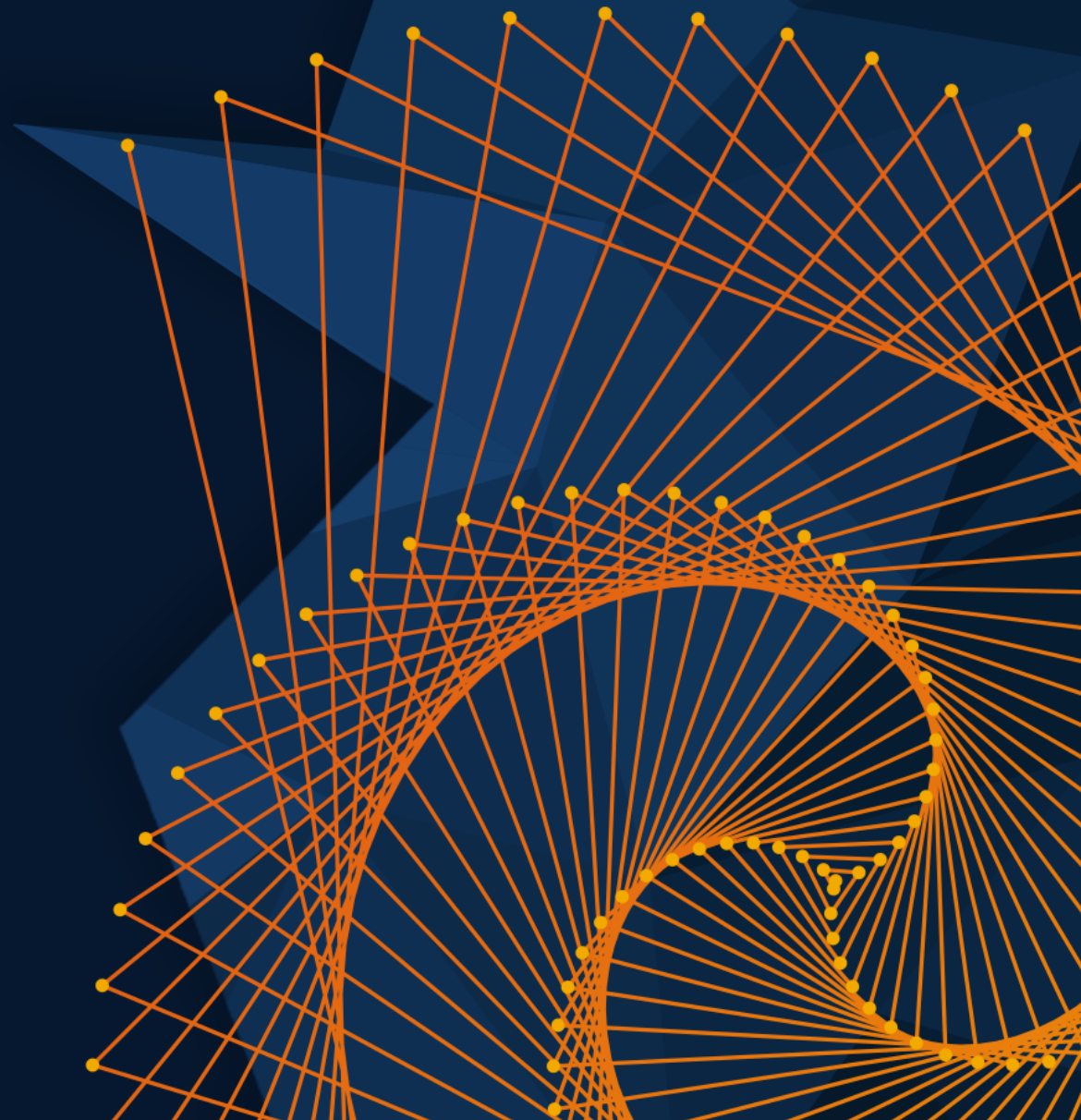
"Two things show up on the happiest workers, the people who have the greatest happiness from work. They feel like they're earning their success, which is to say that they're creating value with their lives and with their work lives, that their ***accomplishments are moving the needle*** and they're being recognized for those accomplishments. And number two, they feel like they're ***serving people*** so that they're needed. These are the two big things."

-Arthur Brooks, Build the Life You Want

Happiness = Enjoyment + Purpose + Satisfaction

https://youtu.be/G7Pf2Xb5PdA?si=dzb8Mi2IVhJEVbyJ

MATLAB EXPO



MathWorks®