EET 4450 Automatic Control Systems Spring 2025

When and where	Lecture (001) NE 2106 T, R - 2:30 – 3:50 pm	Lab (002) NE 2350 T 4:00 - 5:25 pm Lab (003) NE 2350 T 12:45-2:25 pm
Instructor	Prof. Wm Ted Evans, PhD, PE (Ohio)-Office: NE 1607, Phone 419-530-3349, cell 419-343-3681 Email: william.evans@utoledo.edu, web www.hybridplc.org	
Office Hours	9:30-12:00 M,W	
Prerequisite	**Prerequisites:** EET 3250 for UG with min of D- or ENGT 3050 for UG with min of D-	
Textbook	All posted on hybridplc.org website under course.	
Useful References	DiStefano et al, Schaums Outlines – Feedback and Control Systems, 2nd ed. Astrom and Murray, Feedback Systems – An Introduction for Scientists and Engineers, v2.11b, online and at hybridplc.org website Liptak, Instrument Engineers' Handbook, Process Measurement and Analysis, Process Control ISA (International Society of Automation), www.isa.org	
Grading	**Homework 10 %, Quizes 10 %, Labs 20 %** **Midterm exam I 20 %, Midterm exam II 20 %** **Completion of 20 Video Reviews 20%**	
Class rules and regulations	1. No eating, drinking, or smoking in classrooms. 2. There are no make-up exams for this course. If you have a problem or conflict and cannot attend an exam, let me know beforehand and we will try to work something out. No credit will be given for a missed exam that we haven't made arrangements about beforehand unless you have a ***really excusable*** emergency. Cell phone use will not be allowed. If you do not have a calculator, buy one and bring it to class. ***Cheating is not allowed and will be punished by rules of U of Toledo Student Handbook.***	
Catalog descriptions	This course is an introduction to industrial controls, including the PID control of closed-loop servo and process systems, with emphasis placed on the electronic circuits of the closed-loop sub-systems.	
Topics and reading assignments (subject to change, any changes will be notified in the class beforehand)	• To study the basic elements of an automatic control system • To use block diagrams to describe the elements of a control system • To study the difference between open-loop and closed-loop systems • To use the knowledge of math and science in deriving the process model and use it in the controller design • To determine and design signal conditioning for the system • To study the operation of different transducers/sensors and their importance in a control system • To be able to design a controller for a system to satisfy a certain performance criterion • To study the operation and performance of different control strategies such as P, PI, PD and PID • To use Bode plots to study the stability of controlled systems • To use labs for hands on experience with different measuring devices and compare different control techniques	
Class dates (Exam dates are subject to change.)	Homework assignments are listed on the website and are accepted only before or on the assigned day. Labs are to be printed from the website and brought to lab. Labs to be graded only if submitted at end of assigned class period. Pop quizzes may occur any day at the end of the class period.	

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	Date	Lecture/Lab Schedule	Homewrk/Lab Due Date
Week 1	1/14	Intro and Terms	
	1/16	Instruments and Linear Conversion	
Week 2	1/21	Automatic Control	
	1/23	Intro to Laplace	HW 1
Week 3	1/28	Laplace Cont, Lab 2	
	1/30	Laplace Cont	HW 2 - Lab 1
Week 4	2/4	Laplace Cont, Lab 3	
	2/6	Laplace Cont	HW 3 thru 4.12 - Lab 2
Week 5	2/11	Laplace Cont, Lab 4	
	2/13	Boxes	HW 4 any 15 - Lab 3
Week 6	2/18	Boxes, Lab 5	
	2/20	Boxes, Laplace Review	HW 5 any 10 - Lab 4
Week 7	2/25	Midterm Test 1, Lab 6	
	2/27	Return Midtern Test 1	Lab 5, all labs, HWs due
Week 8	3/4	Spring Break	
	3/6	Spring Break	HW6
Week 9	3/11	Bode Plot, Lab 7	
	3/13	Measurements – PPT 158-203	
Week 10	3/18	Sensors – PPT 204-249, Lab 8	Lab 6
	3/20	Pressure and Flow – PT 250-284	
Week 11	3/25	Level – PPT 285-308, Cognex Video – Introduction, Lab 9	Lab 7
	3/27	Temperature – PPT 309-351	
Week 12	4/1	Control Valves – PPT 352-372, Lab 10 (Cognex 3)	Lab 8
	4/3	Pneumatics – PPT 373-391	HW 7
Week 13	4/8	Electric Machines – PPT 392-435, Lab 11 (Cognex 4)	Lab 9
	4/10	PID Revisited – PPT 436-499	HW 8
Week 14	4/15	Review, Lab 12 (Cognex 5)	Lab 10
	4/17	Review	
Week 15	4/22	Test 2	HW 4a and 4b
	4/24	Return Test and Wrap Up	Lab 11, 12
Week 16		Final Exam Week – Hand in Video Reviews	

Tacoma Narrows Bridge Collapse "Gallopin' Gertie"
http://www.youtube.com/watch?v=j-zczJXSxnw

How to Read a P&ID? (Piping & Instrumentation Diagram)
https://www.youtube.com/watch?app=desktop&v=j4EOTerfyTY&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=1
Kaufman
https://www.youtube.com/watch?v=eXB2qHsVsfM&list=PLj10k9JPIMAGPAIylqEkEr-oGKIMQPsge
What is a Fourier Transform?
https://www.youtube.com/watch?v=wmCIrpLBFds

More information can be found on MATLAB at:
https://rocketsutoledo.sharepoint.com/sites/ecchelp/eccwiki/ENG%20Virtual%20Labs.aspx

Modal Testing Seminar
https://community.sw.siemens.com/s/article/Modal-Testing-Seminar

How to Read a Datasheet
https://www.youtube.com/watch?app=desktop&v=lWsh_ldxiUQ&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=63

Limit Switch Explained – Working Principles
https://www.youtube.com/watch?app=desktop&v=8v7fInvKNQM&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=16

Diode Module | How does it work?
https://www.youtube.com/watch?app=desktop&v=gQNSpEOz5mM&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=17

Terminal Blocks Explained
https://www.youtube.com/watch?v=X-kZ2ksav8g&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=19

What is a Sensor? Different Types of Sensors, Applications
https://www.youtube.com/watch?app=desktop&v=XI49uFm5HRE&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=12

Smart Sensor Explained | Different Types and Applications
https://www.youtube.com/watch?app=desktop&v=5b5xJu8KYrc&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=13

What is a Transistor | Working Principles
https://www.youtube.com/watch?app=desktop&v=YtM_MnM0qT4&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=21

Basics of the Linear Variable Differential Transformer (LVDT)
https://www.youtube.com/watch?app=desktop&v=o_hEmYip248&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=55

Photoelectric Sensor Explained (with Practical Examples)
https://www.youtube.com/watch?app=desktop&v=l1rjErRvbgw&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=34

Photoelectric Sensor Wiring and Setup
https://www.youtube.com/watch?app=desktop&v=g3utyglYy0E&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=36

3-wire Inductive Proximity Sensor | How to Read the Datasheet

https://www.youtube.com/watch?v=DtNyLZ-BGa4&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=11

Inductive Sensor Explained | Different Types and Applications
https://www.youtube.com/watch?v=o4_6yu-GIDU&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=37

Transmitter Explained | Types of Transmitters
https://www.youtube.com/watch?v=DtNyLZ-BGa4

Pressure Sensor, Transducer, and Transmitter Explained | Application of Each
https://www.youtube.com/watch?app=desktop&v=DVq10SGKHMU&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=41

How to Measure Flow Rate with a DP Transmitter
https://www.youtube.com/watch?app=desktop&v=e169sklQ5Ys&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=2

DP Flow Transmitter Testing and Recalibration
https://www.youtube.com/watch?v=4MzFQtQOl3c&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=3

Turbine Flow Meter Explained | Operation and Calibration
https://www.youtube.com/watch?app=desktop&v=-RvwXGzzv4c&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=29

Ultrasonic Flow Meter Explained | Working Principles
https://www.youtube.com/watch?app=desktop&v=JRKlR4YgMHw&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=43

Magnetic Flow Meter Explained | Working Principles
https://www.youtube.com/watch?app=desktop&v=D999KDUj_QU&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=70

Pressure Gauge Explained | Types of Gauges
https://www.youtube.com/watch?app=desktop&v=muWuIJS_F7k&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=50

Pressure Transmitter Explained | Working Principle
https://www.youtube.com/watch?app=desktop&v=zS77qnlEPg0&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=9

Differential Pressure Transmitter Explained
https://www.youtube.com/watch?v=XkMEto_x22A

The Differential Pressure Flow Measuring Principle (Orifice-Nozzle-Venturi)
https://www.youtube.com/watch?v=oUd4WxjoHKY

Manometer Explained | Working Principle
https://www.youtube.com/watch?app=desktop&v=gxrkLkJybnA&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=20

Pressure Switch Explained | Types of Pressure Switches
https://www.youtube.com/watch?app=desktop&v=1VdSxSRhadM&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=33

Bernoulli Equation
https://www.youtube.com/watch?v=DW4rItB20h4

DP Level Measurement Explained

https://www.youtube.com/watch?app=desktop&v=ylhwPcyieTc&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=5&pp=iAQB

DP Closed Vessel Level Measurement Explained
https://www.youtube.com/watch?app=desktop&v=VyHIgqqpGEc&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=7&pp=iAQB

Capacitive Sensor Explained | Different Types and Applications
https://www.youtube.com/watch?app=desktop&v=o4_6yu-GIDU&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=37

Thermocouple Explained | Working Principles
https://www.youtube.com/watch?app=desktop&v=mNoI62URtAk&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=54

How to Choose a Thermocouple (with Practical Examples)
https://www.youtube.com/watch?app=desktop&v=5IS6jq6IaVU&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=56

Understanding Temperature Sensor Technology: RTDs, Thermocouples, and Thermistors
https://www.youtube.com/watch?app=desktop&v=J2ulD-bPTS4&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=76

Temperature Transmitter Explained | Connection and Calibration
https://www.youtube.com/watch?app=desktop&v=Kq22wxqzJ7g&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=44

What is an RTD | Working Principles
https://www.youtube.com/watch?app=desktop&v=7nsIJ5fOLJ8&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=73

RTD Installation and Maintenance 101: A Beginner's Guide
https://www.youtube.com/watch?app=desktop&v=Fut1AYx0QAc&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=78

RTD vs Thermocouple: Which is Better for Your Needs?
https://www.youtube.com/watch?app=desktop&v=J2ulD-bPTS4&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=76

How to Wire a Thermocouple to a PLC
https://www.youtube.com/watch?app=desktop&v=ZG574Ss56HA&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=58

What is a Control Valve?
https://www.youtube.com/watch?app=desktop&v=KtsiM1st0KA&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=14

Valve Sizing
https://www.youtube.com/watch?v=ldLkbV3W7Pk

Festo Pneumatic Control
https://www.youtube.com/watch?v=5q7YasmwXCs

FluidSIM
https://www.youtube.com/watch?v=ajLRtRs92lY

Big Bad Tech – Jim Pytel
https://atecentral.net/r44246/pneumatic_flow_control_methods_part_1_of_2

https://atecentral.net/r44247/pneumatic_flow_control_methods_part_2_of_2
https://www.youtube.com/watch?v=zHto_QiORz0&list=PLdnqjKaksr8qM_nxfOnZhELfIlr6auQZG

https://openoregon.pressbooks.pub/hydraulics/chapter/1-2-hydraulics-math/#pb-interactive-content

https://openoregon.pressbooks.pub/hydraulics/

Pytel - motor starter with jogging
https://www.youtube.com/watch?v=jcpXV9-ww1c&list=PLdnqjKaksr8qRPCFkU2Q8XQe0bfo99rs6&index=30
DC Motor
https://www.youtube.com/watch?v=CWulQ1ZSE3c
AC Motor
https://www.youtube.com/watch?v=59HBoIXzX_c
VFD
https://www.youtube.com/watch?v=yEPe7RDtkgo

Motor Starter Explained | Motor Starter Types
https://www.youtube.com/watch?app=desktop&v=wEwX2PRebVU&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=26

What is a Contactor? | Working Principles
https://www.youtube.com/watch?app=desktop&v=08ozhRb7HEU&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=38

https://www.youtube.com/watch?app=desktop&v=08ozhRb7HEU&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=38

Electrical Grounding Explained | Basic Concepts
https://www.youtube.com/watch?v=YO-Dnk6ZKrI&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=32

Variable Frequency Drives Explained | VFD Basics - Part 1
https://www.youtube.com/watch?app=desktop&v=HayryySX_po&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=57

Variable Frequency Drives Explained | VFD Basics - Part 2
https://www.youtube.com/watch?app=desktop&v=DXjXh0cF8Kc&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=62

Kalman Filter with Student Dave
https://www.youtube.com/watch?v=FkCT_LV9Syk
https://www.youtube.com/watch?v=NT7nYv9Ri2Y

What are 2-Wire and 4-Wire Transmitter Output Loops?
https://www.youtube.com/watch?app=desktop&v=Bk5bLrzwLII&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=4

Interpreting Typical Analog Input Control Loop Diagrams
https://www.youtube.com/watch?app=desktop&v=fcF6ivDavrQ&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=8

WiFi vs Industrial Wireless - What is the Difference?
https://www.youtube.com/watch?app=desktop&v=QP8WF4UCmcw&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=22

Pressure Transducer and Transmitter Wiring Explained
https://www.youtube.com/watch?app=desktop&v=dt4Q69yMZYE&list=PLln3BHg93SQ9fq9jcwARIFCmrpXE2rZuj&index=53