NI Week Lab Tour
ME 144L
Dynamic Systems and Controls Lab

Course Instructors:
Prof. Raul G. Longoria
Prof. Eric Fahrenthold

Teaching Assistant:
Jacob Adams

Department of Mechanical Engineering
The University of Texas at Austin
NI Week Lab Tours, August 4, 2014

http://www.me.utexas.edu/~dsclab
http://www.me.utexas.edu/~dsclab/clog.html
Dynamic Systems & Controls

- **ME 344 = Dynamic Systems & Controls (DSC)**
  - 3 hrs lecture per week, ~16 weeks/semester, required course
  - Systems modeling, analysis/simulation, basic feedback control; bond graph approach
  - 2 lectures sections taught by 2 different instructors

- **ME 144L = DSC Lab**
  - 1 hr lecture per week, 2 hrs lab, required course
  - Fall, Spring offerings: ~140 students, 4-6 TAs, 8-12 lab meetings

- **Student background:**
  - ME senior level
  - Basic circuits and electronics (mechatronics)
Key background for this course relates to material in:

ME 318M = Engineering Computational Methods (numerical methods using Matlab)

ME 340/140L = Mechatronics and Mechatronics Lab (introduction to circuits, electronics, electromechanics, some controls concepts; use of LabVIEW for data acquisition and testing)

Prior to 2008, students enrolled in a traditional circuits/electronics course for non-EEs taught in our ECE department.

NOTE: Very few of our undergraduates enroll in our elective controls course
Core concepts

• Model-based experimentation
• Numerical analysis (Euler, RK4, etc.)
• Basic electrical testing and measurement
• Signal conditioning, measurement, and analysis
• Computer-based measurement/control
• Sensor and actuator technologies
• Basic feedback control
• Uncertainty analysis*
LabVIEW-based Instruction

MODELING & SIMULATION

DATA ACQUISITION, SENSORS, TEST & MEASUREMENT

FEEDBACK

Reference Signal

Error Signal

Controller

Disturbance

Plant

Output

Feedback Signal

Sensor

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NI myDAQ

From NI myDAQ User Manual:

NI myDAQ is a low-cost portable data acquisition (DAQ) device that uses NI LabVIEW-based software instruments, allowing students to measure and analyze real-world signals. NI myDAQ is ideal for exploring electronics and taking sensor measurements. Combined with NI LabVIEW on the PC, students can analyze and process acquired signals and control simple processes anytime, anywhere.

myDAQ works directly with NI ELVISmx Software Instruments
See: http://zone.ni.com/devzone/cda/tut/p/id/11420
Two-can system modeling, experiments, simulation
Be able to go from intuition to quantitative models
Using block diagrams to represent systems

If \( x < 0 \), \( y = 0 \)
otherwise \( y = x \)
Learn sensors, measurement, and comparisons to models
Low-cost controls lab

- Basic webcam (~$35)
- USB-6008 (~$150) OR myDAQ
- Analog meter (~$15)

A highly-portable, low-cost controls lab. Cost becomes insignificant if existing DAQ is used.
Compact, simple EM system

Electrical circuit model

Mechanical model

Series resistor

Front View

Rear View

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Learn very basic use of vision

• Learn how to **read/create image files** using LabVIEW, and how to manage those files
• Learn about built-in functions for **analyzing image files** (select areas, measure intensity, etc.)
• Learn how to **acquire images** using a USB camera
• Build a **vision-based measurement** system, particularly for object motion.
2 or 3 Weeks of Lab

1. Basic Vision – use the analog meter, modified to provide a ‘moving bob’ to be visualized using USB webcam

2. Open Loop Control – drive the ‘bob’ to desired positions using ‘calibrated’ reference signal; use vision to verify motion; system identification

3. Closed Loop Control – demonstrate use of PID type controls with USB vision in the loop
System Identification

Analog Meter

Input voltage → Needle position

USB WebCam

Input voltage → Needle position

Introduced time delay

Measured Needle position

Comparison of Amplitude Data to Model

Comparison of Phase Data to Model
Summary and Demo

• This is a core laboratory course and not a ‘controls course’. Consequently, the curriculum targets a more general audience of mechanical engineering students.
• The basic hardware can be used to demonstrate fundamental as well as advanced controls concepts.
• Emphasize physical modeling and simulation
• Use of data acquisition, vision acquisition
• Sensor basics, making the right connections
• Learn a little about the difference between open and closed loop control – try to plant a seed
• Ability to use LabVIEW to accomplish a wide range of engineering tasks