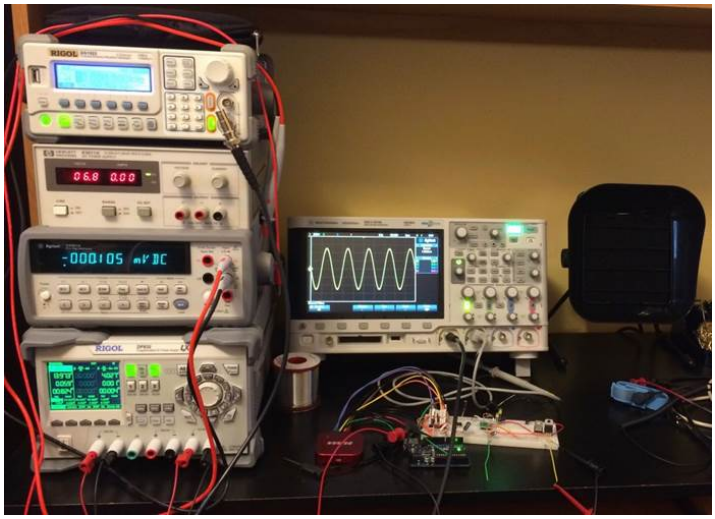
Physics 5760/6760 - Principles of Physical Measurement and Instrumentation
Lecture and Laboratory
Spring 2018


(u.osu.edu/stepcreative16/2016/12/28/electronic)

Professor:	Clayton Williams
Office:	302 N. Physics
Phone:	585-3226
Office Hrs:	Tuesday 3:30-4:30 pm in 217 JFB (or by appointment)
Lecture:	Monday, Tuesday: 4:35-5:25, South Physics Bldg, Room 302)
6775 Lab:	Wednesday: 4:35-8:35 pm, South Phys. Room 302 (1 4 hours lab / week)
Lab Instr:	Gernot Laicher
Class begins:	Monday, January 8
Last class:	Tuesday, April 24
Mid. Exam:	To be arranged, Phys 302

Holidays:	Martin Luther King Jr. Day holiday	Mon, Jan 15
	President's Day holiday	Mon, Feb 1
	Spring Break	Mon-Friday, Mar 18-25

Text: Robert B. Northrop, Introduction to Instrumentation and Measurements, 3rd Edition, CRC Press (Taylor & Francis Group), Dover Publishers, Florida, 2014
ISBN 978-1-4822-1482-6
Any edition acceptable

References: J. Bentley, Principles of Measurement Systems

Overview
Quantitative measurements are performed in every area of science, engineering and technology, providing a critical comparison of reality with theoretical predictions. Measurements are employed to control, calibrate and diagnose physical processes. In order to accurately perform measurements, one must understand the basic principles of metrology, the science of measurement. This course is focused on teaching basic measurement concepts and sensing methods. The concepts include random include static and dynamic system response, system calibration, systematic & statistical error analysis, noise, signal filtering/averaging, impedance effects and frequency/time domain analysis. The methods include optical, thermal, magnetic, acoustic and electrical sensing approaches.

During the first 7 weeks, a weekly laboratory will help students gain hands-on experience with the concepts and methods. During the next five weeks, students will engage in solving an extended "less-structured" measurement challenge. Students will choose from a set of challenging experimental problems (or propose their own), design and build a system to achieve their goal, demonstrate that it works, characterize the system performance and present their results to the class. The "less-structured" problem solving experience will develop useful skills that standard courses often do not require. The problem solving component will be managed somewhat like a "technology incubator," in which solutions to "real world" problems are developed.

*The 6760 version of this course satisfies the core course requirements for the Science Instrumentation track of the Professional Masters of Science and Technology (PMST) program.

Course Objectives
1. Understand the basic concepts of quantitative measurements & instrumentation
2. Experience with many useful sensing methods
3. Solve a "less-structured" real-world measurement challenge

The lectures and homework will cover the general measurement principles and basic physics behind the instrumentation/sensors. The laboratory will provide "hands on" experience with the measurement concepts and physical sensors.

Course Mechanics
Required prerequisite: Engineering physics sequence (Phys 2210,2220) or equivalent
Lectures: Lectures will cover the concepts and sensing approaches needed to do the laboratory work and homework.
Laboratory: a total of seven lab experiments will be done. One laboratory session will be scheduled each week, typically taking 4 hours. A laboratory write-up will be due at the beginning of class on the Monday following the laboratory session. Laboratory reports that are turned in late will receive reduced credit. Gernot Laicher will direct the labs and grade the lab write-ups.
Homework: There will be regular homework problem sets given each week which will

help prepare students for the laboratories.
Exams: A midterm and comprehensive final exam will be given.
Lab Presentation: Each student will make a presentation of the results of his 5 week "measurement challenge" project. The talk should be 10 minutes, summarizing all of the key results and analysis.

Grading

Student performance will be judged on the exams, problem sets and lab presentations *approximately* weighted as shown below:

Problem sets	10%
Laboratory	30%
Measurement Challenge Project	30%
Midterm Exam	30%

Grading (Laboratory write-ups)

The laboratory component of the course will determined by performance in the laboratories (25%) and on the weekly laboratory reports (75%).

Weekly Laboratories
1. Electronic amplifiers (voltage, current, addition, subtraction, filter, integrators)
2. Static measurement system characterization (capacitance, position sensing)
3. Dynamic 1st order system (thermoresistor, dynamic response)
4. Dynamic 2nd order system (Optical beam displacement, resonance)
5. Feedback loop (closed loop response, gain, oscillation)
6. Ultrasonic sensing (piezoelectric transducer, distance measurement)
7. Magnetic sensing (Hall sensor, vector magnetic field)
8. Linear variable differential transformer (displacement measurement)