Environmental Instrumentation

Plants, Soils and Climate 5000/6000

Fall Semester 2019 - 2 credits

Instructor: Bruce Bugbee
Teaching assistants: Shuyang Zhen, Paul Kusuma and Will Wheeler

Objective

To provide an overview of measurement instrumentation used in environmental, agricultural, and meteorological applications, including:

1. **The physics of signal transduction:** How sensors convert environmental parameters into electric signals.

2. **Interfacing sensors with meters**: Ohm's law, principles of grounding; voltage dividers, single ended and differential measurements, maximizing signal to noise ratio.

3. **Data collection and processing:** Programming dataloggers to optimize measurement accuracy and summarize data.

Text: No formal text. Extensive handouts and on-line resources.

Meeting time is arranged: One hour lecture followed by a two hour lab each week.

Labs: There will be six labs that demonstrate the use of the instruments discussed in lecture. Students will write datalogger programs, interface sensors with dataloggers, and make measurements. A lab report, due the following week, is required with each lab. The lab reports should concisely summarize the principles of the measurements being made, describe materials and methods used to make the measurements, present results in the form of tables and graphs, discuss the results, and state conclusions. Three references should be cited from the on line literature.

Project: Each student will develop and execute an independent project. This can be a portion of the student's graduate research. The project report includes a written report and an in-class presentation. The report and presentation should include the underlying principles of the instrumentation, the application it was used in, and conclusions from the project. The format for the paper is the same as that for lab reports, but should be expanded to include more detail, similar to a refereed journal publication.

Grading

	Percent of Final Grade	Points
Take-home Midterm Exam	22 %	220
Comprehensive Final Exam	25 %	250
Lab Reports	24 % (6 reports @ 40 points)	240
Project	29 % (report: 150; presentation: 80)	290
Total		**1000**

Exams

There will be two exams, a take-home midterm and a comprehensive final. The take-home midterm exam will be approximately half-way through the semester. You can use all available resources except people.

Everybody believes a measurement – *except* the guy who made it.

Nobody believes a model – *except* the guy who came up with it.

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Never believe a measurement
unless it can be substantiated with theory.

The confidence we have a measurement is determined by the degree to which theory and measurement agree.

Schedule

Week of	
Week 1 (Aug 26)	Overview: Automated data acquisition. Separating the signal from the noise. Connecting dataloggers with computers.
Week 2 (Sept. 2)	Measurement of Temperature **LAB 1: Temperature Measurement**
Week 3 (Sept 9)	Measurement of Humidity **LAB 2: Humidity Measurement**
Week 4 (Sept 16)	Measurement of Solar, UV, and Photosynthetic Radiation **LAB 3: Radiation Measurement**
Week 5 (Sept 23)	Spectral Imaging – reflection and transmission **LAB 4: Spectral Imaging**
Week 6 (Sept 30)	Measurement of surface temperature by Infra-red Radiation Measurement of wind speed and direction
Week 7 (Oct 7)	*Tour of Cache Valley instrument companies*
Week 8 (Oct 14)	*Take home midterm exam*
Week 9 (Oct 25)	Measurement of precipitation and surface moisture
Week 10 (Oct 21)	Measurement of Soil Water Content and Water Potential **LAB 5: Soil Water Content and Water Potential**
Week 11 (Oct 28)	Measurement of CO_2, O_2, and other gases **LAB 6: Measurement of the CO_2 flux in respiration**
Week 12 (Nov 4)	calculating the necessary size of a solar power system for continuous operation in the winter
Week 13 (Nov 11)	**Thanksgiving break**
Week 14 (Nov 18)	Calculating solar power/battery requirements for remote stations
Week 15 (Nov 25)	Presentation of Projects
Week 16 (Dec 2)	Presentation of Projects
Week 17 (Dec 9)	Comprehensive Final