Meteorology 432/532 – Instrumentation and Measurements
Spring 2009

Instructors: Igor Beresnev, 164 Science I, 4-7529, beresnev@iastate.edu
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Class Time: MWF 2:10-3:00, 1022 Agronomy

Text: **Main**: *Meteorological Measurement Systems*, F. V. Brock and S. J. Richardson, Oxford University Press, 2001, ISBN 0-19-513451-6
Additional: *An Introduction to Meteorological Instrumentation and Measurement*, T. P. DeFelice, Prentice Hall, 1998, ISBN 0-13-243270-6

Prerequisites: Stat 105, Math 266, Phys 222

Course Fee: $20 (materials and field trips)

Philosophy

This course is an elementary introduction to the physics of sensing as it is used in meteorological measurements. The class generally follows the outline of the main textbook by Brock and Richardson, except the material that is not covered in the book. The lectures are designed to be self-sufficient, in that only the material given in class will enter exams and problem-set assignments. Familiarity with elementary differential equations is expected for understanding the principles of sensor-response analysis. The math is kept at a simple level and used primarily for the illustration of concepts; advanced math skills are not required to complete the assignments. The course includes several measurement and data-processing labs, arranged by D. Flory, and introductory visits to and demonstrations at the National Soil Tilth Lab (see **Laboratory topics** below). We also arrange for a guest lecture by meteorologists from the National Weather Service and a field trip to their radar facility. The field trip will take half-a-day on a date agreed upon.

Laboratory and demo/visit topics

1. Data loggers (Flory)
2. Instrument introduction (Soil Tilth Lab)
3. Barometry (Flory)
4. Time constants (Flory)
5. Sonic anemometers (Soil Tilth Lab)
6. Hot-wire anemometers (Soil Tilth Lab)
7. Tipping-bucket rain gauge (Flory)
8. Weather-station setup (Soil Tilth Lab)
9. Field site with 50’ tower (Soil Tilth Lab)
10. Data analysis (Flory)

Problem-set assignments

Problem assignments will conclude presentation of the blocks of material. There will tentatively be three problem sets, due two weeks following the day they have been handed out; grades will be lowered at a rate of 5 % per day for late returns.

When working on a problem assignment, please keep in mind these simple rules:

(1) Carefully explain all your work and the steps taken in arriving at final solution. No problem is considered complete with only a final answer provided.

(2) Make the final result clearly seen.

Student presentations

All students will be required (in groups of two) to select a subject related to sensors, instrumentation, or measurements, research it, and make a presentation during the last week of the semester (see **Schedule** below). The format of the presentation is 12 + 4 (12 minutes for the talk, 4 minutes for questions). The formation of groups and topic selection should be reported by Monday, February 9.

Written exams

There will be two exams, one mid-term and one final, which will cover the respective half of the course. The exams will include questions requiring short answers and problems; the problems will be similar to those given in the homework and will cover only the lecture material. All exams require calculator and paper and will be 50-min. exams.

Course grading

Exams (average)	45 %
Assignments/Labs (average)	35 %
Presentations	20 %

Schedule

Date	Topic
Week 1 / January 12-16	Introduction. Uncertainties in the measurements. Error analysis. Propagation of errors.
Week 2 / January 19-23	Static-performance characteristics. Static sensitivity. Transfer plots. Calibration.
Week 3 / January 26-30	Thermometry
Week 4 / February 2-6	**Lab # 1** – Data loggers (Flory) (Monday) Barometry
Week 5 / February 9-13	**Lab # 2** – Instrument introduction (Soil Tilth Lab) (Monday) Barometry (cont). Hygrometry
Week 6 / February 16-20	**Lab # 3** – Barometry (Flory) (Monday) Dynamic sensor performance – First-order systems
Week 7 / February 23-27	First-order systems (cont.) Radar (NWS **guest lecture** and **field trip**) (Wednesday, Friday)
Week 8 / March 2-6	**Lab # 4** – Time constants (Flory) (Monday) **Lab # 5** – Sonic anemometers (Soil Tilth Lab)

	(Wednesday) Anemometry/Profilers
Week 9 / March 9-13	**Exam # 1** (Monday) **Lab # 6** – Hot-wire anemometers (Soil Tilth Lab) (Wednesday) Precipitation

March 16-20 **Spring Break**

Week 10 / March 23-27	**Lab # 7** – Tipping-bucket rain gauge (Flory) (Monday) Radiation
Week 11 / March 30-April 3	Dynamic sensor performance – Second-order systems. Visibility and clouds.
Week 12 / April 6-10	**Lab # 8** – Weather-station setup (Soil Tilth Lab) (Wednesday) Upper-air measurements. Remote sensing.
Week 13 / April 13-17	Signal processing: quantization, sampling, spectral analysis
Week 14 / April 20-24	**Lab # 9** – Field site with 50' tower (Soil Tilth Lab) (Monday) **Lab # 10** – Data analysis (Flory) (Wednesday) Signal processing (cont): spectral analysis, filtering
Week 15 / April 27-May 1	**Student presentations**

Week of May 4-8 **Final Exam**