Meteorology 432 – Instrumentation and Measurements
Spring 2011

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: $ 120-170 (materials and field trips)

Philosophy

The 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 enters the 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 is used primarily for the illustration of concepts; advanced mathematical 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 Laboratory for Agriculture and the Environment (NLAE) (see **Laboratory topics** below). One visit will take place to the wind tunnel at the ISU Department of Aerospace Engineering. 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 is mandatory and takes half-a-day on the date announced in the syllabus. It is the students' responsibility to arrange for no conflicts of the time of the trip with work schedule etc.

Laboratory and demo/visit topics

1. Data loggers (Flory)
2. Instrument introduction (NLAE)
3. Barometry (Flory)
4. Time constants (Flory)
5. Sonic anemometers (NLAE)
6. Hot-wire anemometers (ISU's Aerospace Engineering)
7. Tipping-bucket rain gauge (Flory)
8. Remote sensing (NLAE)
9. Weather-station setup (NLAE)
10. Field site with 50' tower (NLAE)
11. Data analysis (Flory)

Problem-set assignments

Problem assignments 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, follow the simple rules:

(1) Carefully explain all your work and the steps taken in arriving at the solution. No problem is considered complete with only the 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 7.

Written exams

There will be two exams, one mid-term and one final, which will cover the respective halves 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. long.

Course grading

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

Schedule

Date	Topic
Week 1 / January 10-14	Introduction. Uncertainties in the measurements. Error analysis. Propagation of errors.
Week 2 / January 17-21	**Lab # 1** – Data loggers (Flory) (Wednesday) Static-performance characteristics. Static sensitivity. Transfer plots.
Week 3 / January 24-28	Calibration. Thermometry.
Week 4 / January 31-February 4	Barometry.
Week 5 / February 7-11	**Lab # 2** – Instrument introduction (NLAE) (Monday) Hygrometry
Week 6 / February 14-18	**Lab # 3** – Barometry (Flory) (Monday) Dynamic sensor performance – First-order systems
Week 7 / February 21-25	First-order systems (cont.) Radar (NWS **guest lecture** and **field trip**)

	(Wednesday, Friday)
Week 8 / February 28-March 4	**Lab # 4** – Time constants (Flory) (Monday) **Lab # 5** – Sonic anemometers (NLAE) (Wednesday) Anemometry/Profilers
Week 9 / March 7-11	**Lab # 6** – Hot-wire anemometers (ISU's Aerospace Engineering) (Monday) **Exam # 1** (Wednesday) Precipitation

March 14-18 **Spring Break**

Week 10 / March 21-25	**Lab # 7** – Tipping-bucket rain gauge (Flory) (Monday) Radiation
Week 11 / March 28-April 1	Dynamic sensor performance – Second-order systems. Severe Storms & Doppler Radar Conference (Friday)
Week 12 / April 4-8	**Lab # 8** – Remote sensing (NLAE) (Monday) Visibility and clouds. Upper-air measurements.
Week 13 / April 11-15	Signal processing: quantization, sampling, spectral analysis, filtering **Lab # 9** – Weather-station setup (NLAE) (Friday)
Week 14 / April 18-22	**Lab # 10** – Field site with 50' tower (NLAE) (Monday) **Lab # 11** – Data analysis (Flory) (Wednesday) **Student presentations** (Friday)
Week 15 / April 25-29	**Student presentations**

Week of May 2-6 **Final Exam**