Meteorology 432 – Instrumentation and Measurements  
Spring 2018

Instructors: Igor Beresnev, 162 Science I, 4-7529, beresnev@iastate.edu  
David Flory, 3101 Agronomy, 4-0264, flory@iastate.edu

Class Time: MF 3:10-4:00, W 3:10-5:00, 1022 Agronomy

Text: Main: Meteorological Measurement Systems, F. V. Brock and  
Additional: An Introduction to Meteorological Instrumentation  

Prerequisites: Math 266, Phys 222

Course Fee: $ 140 (materials, equipment, field trip)

Learning objectives and philosophy
The overarching goal of the course is for you to understand the physical principles behind  
meteorological sensors and the quality of the data that they supply.

Consequently, there are four main learning objectives:

(1) Introduction to the physics of sensing as it is revealed in the main types of  
meteorological measurements.

(2) Learning quantitative means of analyzing the sources of errors and uncertainties in  
meteorological data and the response of sensors to static and varying meteorological inputs.

(3) Understanding the principles of the representation of digital data and its storage in  
computer memory.

(4) Acquisition and analysis of measurements by modern weather stations.

The course 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 appears on the exams and in problem-set  
assignments. Familiarity with elementary differential equations is expected for  
understanding the principles of sensor-response analysis. The mathematics is kept at a  
simple level and is used primarily for the illustration of concepts; algebra and elementary  
calculus are sufficient to complete the assignments.

The course includes 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). We also organize a guest lecture by  
the 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 their availability for the period of the trip.
Laboratory and demo/visit topics
1. Data loggers (Flory)
2. Instrument introduction (NLAE)
3. Barometry (Flory)
4. Sonic anemometers (NLAE)
5. Time constants (Flory)
6. Wind measurement: Anemometry and direction (Flory)
7. Tipping-bucket rain gauge: Demo and programming (Flory)
8. Remote sensing (NLAE)
9-10. Weather-station setup (Flory)
11. Field site with 50’ tower (NLAE)

Problem-set assignments
Problem assignments will conclude presentation of the blocks of material. There will tentatively be three problem sets, each due two weeks following the day it has been handed out; the grades will be lowered at the rate of 5 percentage points per day for late returns.

When working on a problem assignment, please follow the simple rules:

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

(2) Make the final result clearly seen.

Student projects
All students will be required (in the groups of two) to select a subject related to sensors, instrumentation, or measurements, research it, and make a presentation during the last four class sessions of the semester (see Schedule below). The topic of the project is open except that it should be original, creative, and related to the material covered in the course. The format of the final talk is 12 + 4 (12 minutes for the talk, 4 minutes for questions). The projects will be graded based on the in-class presentation, judged on the technical quality and presentation quality. The formation of groups and the topic selection should be reported to the instructors by Monday, February 26. All students are required to attend all presentations.

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

Course grading
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<tbody>
<tr>
<td>Exams (average)</td>
<td>45 %</td>
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<tr>
<td>Assignments/Labs (average)</td>
<td>35 %</td>
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<td>Presentations</td>
<td>20 %</td>
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Rules of mutually respectful business conduct
(1) Electronic devices unrelated to the class content must be turned off
(2) No leisurely conversations or whispering during the class time
(3) Business attitude and posture must be observed

**Schedule**

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<tr>
<th>Date</th>
<th>Topic</th>
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| Week 2 / January 15-19 | **Lab # 1** – Data loggers (Flory) (Wednesday)  
Static-performance characteristics. Static sensitivity. Transfer plots. |
| Week 3 / January 22-26 | Calibration. Thermometry.                                           |
| Week 4 / January 29-February 2 | Thermometry (cont.). Barometry.                                     |
| Week 5 / February 5-9  | **Lab # 2** – Instrument introduction (NLAE) (Monday)  
**Lab # 3** – Barometry (Flory) (Wednesday)  
Hygrometry |
| Week 6 / February 12-16 | Hygrometry (cont.)  
Radar (NWS guest lecture and field trip)  
(Wednesday, Friday) |
| Week 7 / February 19-23 | Dynamic sensor performance – First-order systems.  
Anemometry. |
| Week 8 / February 26-March 2 | **Lab # 4** – Sonic anemometers (NLAE) (Monday)  
**Lab # 5** – Time constants (Flory) (Wednesday)  
Anemometry/Profilers (cont.) |
| Week 9 / March 5-9  | **Exam # 1** (Monday)  
**Lab # 6** – Wind measurement: Anemometry and direction (Flory) (Wednesday)  
Precipitation |
| March 12-16          | Spring Break                                                      |
**Lab # 7** – Tipping-bucket rain gauge: Demo and programming (Flory) (Wednesday)  
Severe Storms & Doppler Radar Conference (Friday) |
<p>| Week 11 / March 26-30 | Dynamic sensor performance – Second-order systems (cont.) |</p>
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<th>Week 12 / April 2-6</th>
<th><strong>Lab # 8</strong> – Remote sensing (NLAE) (Monday)</th>
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<td>Visibility and clouds. Upper-air measurements.</td>
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<td>Week 13 / April 9-13</td>
<td><strong>Signal processing:</strong> quantization, sampling, spectral analysis, filtering</td>
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<td><strong>Labs # 9 and 10 – Weather-station setup</strong> (Flory) (Wednesday and Friday)</td>
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<td>Week 14 / April 16-20</td>
<td><strong>Signal processing (cont.)</strong></td>
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<td><strong>Lab # 11 – Field site with 50’ tower (NLAE)</strong> (Wednesday)</td>
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<td><strong>Student presentations</strong> (Friday)</td>
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<td>Week 15 / April 23-27</td>
<td><strong>Student presentations</strong></td>
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| Week of April 30-May 4 | **Final Exam** |