Meteorology 432 – Instrumentation and Measurements
Spring 2017

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

Class Time: MW 3:10-4:00, F 3:10-5:00, 1022 Agronomy


Prerequisites: Math 266, Phys 222

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

Learning objectives and philosophy

The overarching goal of the course is for the students to understand the physical principles behind the 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 used in the main types of meteorological measurements.

(2) Learning the quantitative means of analyzing the sources of errors in meteorological data and the response of the 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 the 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 these 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 periods of the semester (see Schedule below). The topic of the project is open except that it should be original and creative. 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 for the technical quality and presentation quality. The formation of the groups and the topic selection should be reported to the instructors by Monday, February 27. All students are expected 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 calculator and paper and will be 50-min. long.

Course grading

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<tr>
<th>Component</th>
<th>Percentage</th>
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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 turned off

(2) No leisurely conversations or whispering during the class time
(3) Business attitude and posture observed

**Schedule**

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<thead>
<tr>
<th>Date</th>
<th>Topic</th>
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<tr>
<td></td>
<td><strong>Lab # 1</strong> – Data loggers (Flory) (Friday)</td>
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<tr>
<td>Week 4 / January 30-February 3</td>
<td>Thermometry (cont.). Barometry.</td>
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<td>Week 5 / February 6-10</td>
<td><strong>Lab # 2</strong> – Instrument introduction (NLAEE) (Monday)</td>
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<td></td>
<td>Hygrometry</td>
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<td><strong>Lab # 3</strong> – Barometry (Flory) (Friday)</td>
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<td>Week 6 / February 13-17</td>
<td>Hygrometry (cont.)</td>
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<td>Radar (NWS guest lecture and field trip) (Wednesday, Friday)</td>
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<td>Week 8 / February 27-March 3</td>
<td>Anemometry/Profilers (cont.).</td>
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<td><strong>Lab # 4</strong> – Sonic anemometers (NLAEE) (Wednesday)</td>
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<td><strong>Lab # 5</strong> – Time constants (Flory) (Friday)</td>
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<td>Week 9 / March 6-10</td>
<td>Precipitation</td>
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<td><strong>Exam # 1</strong> (Wednesday)</td>
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<td><strong>Lab # 6</strong> – Wind measurement: Anemometry and direction (Flory) (Friday)</td>
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<td><strong>March 13-17</strong></td>
<td><strong>Spring Break</strong></td>
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<td><strong>Lab # 7</strong> – Tipping-bucket rain gauge: Demo and programming (Flory) (Friday)</td>
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<td>Week 11 / March 27-31</td>
<td>Dynamic sensor performance – Second-order systems (cont.)</td>
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<td>Severe Storms &amp; Doppler Radar Conference (Friday)</td>
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<td>Week 12 / April 3-7</td>
<td><strong>Lab # 8</strong> – Remote sensing (NLAEE) (Monday)</td>
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<td>Week 13 / April 10-14</td>
<td>Visibility and clouds. Upper-air measurements.</td>
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<td>Signal processing: quantization, sampling, spectral analysis, filtering</td>
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<td>Labs # 9 and 10 – Weather-station setup (Flory) (Wednesday and Friday)</td>
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<td>Week 14 / April 17-21</td>
<td>Signal processing (cont.)</td>
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<td>Student presentations</td>
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<td>Lab # 11 – Field site with 50’ tower (NLAE) (Friday)</td>
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<td>Week 15 / April 24-28</td>
<td>Student presentations</td>
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<td>Week of May 1-5</td>
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<td>Final Exam</td>
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