

## 39-651 Special topics course: Computer-aided instrumentation and characterization

This is a course in computer-aided instrumentation and characterization. The course is limited to 16 total students, with at most 8 in each of the two lab sections. This course is intended for graduate students who intend to use Labview in the course of their research. It is assumed that students have access to laboratory equipment appropriate for computer control and a (legal!) installed version of Labview. If space permits I will allow a small number of graduate or undergraduate students without laboratory access to group with a graduate student for a project.

Registration to this course is only by permission of the instructor. While this course is intended for graduate students undergraduate students with appropriate background and senior standing will be registered if space is available. "Appropriate background" means coursework with substantial related intellectual and/ or laboratory content.

**Lectures: MW 3:00- 4:20 PM, BH 231B**

*There will be two lectures/ week during the first part of the semester. Independent project work will be performed during the remainder of the semester.*

**Labs will take place in HH1202, schedule to be determined.**

### **Objectives of the course:**

1. Introduce students to the use of Labview, a commonly used tool for instrument control.
2. Develop a fundamental understanding of important issues encountered in instrumentation and device characterization, including accuracy, resolution, noise, parasitics, and grounding that will enable students to critically assess their data and to rapidly develop solutions to new measurement problems.
3. Encourage a systematic approach to the development of instrument control software, including overall planning, partitioning into testable and reusable pieces, incorporation of error detection and error handling, and provision of a user-friendly interface.

### **Organization**

This course will be scheduled for two lecture sessions, approximately 1.5 hours long, per week. It is expected that these lectures will be used through at least the first half of the course. There will be no lectures for a period toward the end of the course when students are completing their projects. A presentation by each group will be required at the end of the semester during the lecture time.

There will be two scheduled laboratory sessions of 3 hours, each of which can accommodate no more than 8 students. These sessions will be scheduled to accommodate the maximum number of students.

It is **required** that students be able to attend one **entire** laboratory session (i.e., you may not schedule another course which conflicts with this one). There is a strict limit on the number of students per session (number of seats) and the number of lab sessions (two, limited by resources).

At the beginning of the course there will be weekly assignments to be completed in laboratory. During the second part of the course students will work on an instrumentation project. Typically these projects will be performed in the student's laboratory. Two- person groups may be appropriate for some projects, however I do expect a clear division of responsibility. We will have a discussion during the first class to determine the nature of those projects.

The projects will involve all essential topics covered in the course including (1) data acquisition from an instrument or instruments; (2) control of the measurement from a front panel designed to present measurement options and results to the user in a logical manner; and (3) analysis of the data using curve fitting or feature extraction.

The grade will be assigned based on project work conducted by groups of at most two students. There might be a quiz or test on some of the lecture material. **I intend for the projects to be reasonable in scope in light of the number of course units.**

**Text:** *Labview(TM) 7.0 Express Student Edition with 7.1 Update* R.H. Bishop, Prentice Hall<sup>1</sup>

**Important note:** This book, as available in the bookstore, comes with a copy of Labview 7 Student Edition which will be very valuable (if not essential) for the course assignments. I believe that versions of the book available for on-line purchase do NOT include the CD.

**Further note:** Labview 8.0.1 is out but is still somewhat buggy according the the bulletin boards. Students can complete their projects using ANY version of Labview between 6.0 and 8.X. Laboratory assignments will use Labview 7.1 because this is a mature, reliable release.

### **On the course content-**

Labview is an important part of the course and gaining facility with this program will be an important outcome from this course. However this course also includes important topics to the experimental scientist or engineer such as the fundamental limitations of instruments and measurement technology issues including noise and interference. The first part of the course will focus on bringing students up to speed with Labview. Later on we will discuss the various measurement technology subjects. The formal lectures will conclude with some discussion of the user interface.

### **Approximate course content (approximate):**

1. Intro to Labview: computer-aided measurement systems; labview and data flow programming; virtual instruments-front panel and sub-vis as "subroutines"; controls and indicators; data types and conversions; operations on numbers; sequence, case, and while loops; running, stopping, and debugging vis; charts and graphs.

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<sup>1</sup> Presently version 8.0.1 of Labview is available. The word on bulletin boards is that this version is not quite ready for prime time. This version may be used in projects although at student's own risk.

2. More labview concepts: arrays and cluster; strings and string manipulation; output to files and input from files; sub-vi creation; charts and graphs revisited and property nodes; state machines; some analysis vis; error-handling.
3. Basic measurements: voltage and current measurements; digitization, sampling, resolution, and accuracy; grounding; frequency and time measurements; waveforms and triggering; impedance measurements; noise and averaging; examples of sensors and devices.
4. DAQ interfacing and data acquisition: DAQ installation and interfacing; automation explorer; analog input; analog output; digital input; digital output; buffering; applied averaging and analysis; essential vis.
5. Instrument interfacing: GPIB characteristics; Visa vs. 488; automation explorer; controller, bus ID, listener, and polling; basic interchange and SRQ; instrument drivers and structure of packaged drivers; essential vis; other bus types (serial, USB); advanced concepts.
6. Instrumentation issues: voltage, current, and impedance; equivalent circuits for measurement systems; noise and interference; fundamental limitations on measurements; grounding.
7. The user interface: who is the user?; guidelines for the user interface; advantages and disadvantages of particular user interface styles; other topics.

### *Course description*

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