University of California, Santa Cruz
Computer Engineering Department
CMPE-167 & 167L, Winter 2015

Sensing and Sensor Technologies

Lecture Room: N. Sci Annex 102, MWF 3:30 – 4:40pm
Laboratory Room: BE161
Instructor: S.C. Petersen (petersen@soe.ucsc.edu)
TA: David Goodman
Office: BE251 (x9-4782)

Course Description:

This course is about the *engineering design* of sensor *systems*. Besides understanding sensors themselves, a worthy topic in its own right, we need to learn how to fit them into a competently designed system. An excellent sensor in a poorly designed system fails to take full advantage of the sensor itself. Thus, we will first discuss the concept of a system, and follow by discussing the concepts and detailed engineering required to competently make use of a broad range of modern sensors having electrical outputs, both passive and active, and how to apply them as they exist technologically today.

Sensors are particularly prevalent today in state-of-the-art *mixed-signal systems*, i.e. those having analog-to-digital and digital-to-analog conversion blocks. These systems bring new and subtle engineering challenges that are not evident in analog-only systems. Hence, besides traditional advanced analog topics, like noise and various operational amplifier topologies, we will take a systems approach to discussing sampling, quantization, aliasing and other mixed-signal topics.

There are many types of sensors and we cannot discuss them all in depth. Hence we will survey a small number of classical types, chosen to broadly illustrate interfacing topics common to a large number of sensors. An aim of the course is to leave you with the competence to independently learn new specific sensors and comprehend the system interfacing demands to make full use of them.

Prerequisite: Electrical Engineering 103. Concurrent enrollment in course 167/L is required. The laboratory introduces hardware design and implementation concepts requiring knowledge of basic electrical circuits and linear systems.

References:

1 Lecture notes and handouts will be given throughout the quarter, along with component datasheets and any related application's notes, typically in pdf form.

2. Handbook of Modern Sensors, by Jacob Fraden, Springer, 4th edition, 2010.
This is a professional desk reference;it is optional, but recommended.

3. Op Amp Applications Handbook, Analog Devices, ed. by Walt Jung, Newnes 2006.
This book is available as an open-source download from AD's website.

4. The Data Conversion Handbook, Analog Devices, ed. by Walt Jung, Newnes 2005.
This book is available as an open-source download from AD's website.

Homework:

Homework will be assigned and collected *during* class sessions. (They may or may not be posted on our website.) To receive full credit, your work must be well organized, literately readable and show evidence of thoughtful attention to each problem. Since many questions will require written discussions, I expect college level writing. First-draft exposition will be considered deficient and graded accordingly. Math-only problems require a restatement of the problem along with brief orienting discussions about the math you will be presenting and interspersed for cohesion internally; convince us that you know and understand what you are doing.

Grading will follow as described below.

A: An "A" grade means *excellent work*, reflecting complete and thoughtful solutions. Numerical correctness is not the sole criterion, conceptual correctness is also very important. Engineering design problems in particular require a clear exposition of the concepts involved.

B: A "B" grades means *very good work*. It typically reflects thoughtful solutions displaying clear evidence of attention to each problem but with conceptual vagueness or unexplained use of math formulae or models. I assign this grade for well-done but partially understood work.

C: A "C" grade means minimally *satisfactory work*. Numerically correct results without evidence of conceptual understanding or thoughtful solution warrant this grade. I will give this grade to answers consisting of mathematical presentations without appropriate preface or orienting discussion. I will also give this grade to poorly organized, difficult to follow, "dash-it-off", non college-level writing. Both of these are typical of assignments done at the last minute (the "exponential-push" strategy).

D: Incomplete problem sets.

… to each of the above, **+** or **-** as appropriate…

Laboratory:

Details about laboratory work, including the basic project assignment, engineering notebooks and reporting, will be handed out and fully discussed during the first scheduled lab session. Note that you must keep a proper chronologically ordered *engineering notebook* that will be used in conjunction with your actual hardware to assess progress and assign grades.

Please note that unlimited and unsupervised use of laboratory equipment (computers, printers etc.) and resources (web-access, email, ftp etc.) is a *privilege*, not a right. Any abuse of equipment or misuse of resources will result in the immediate loss of these privileges, and may result in disciplinary action by the University. Note too that all food and beverages are expressly prohibited in lab, and the door should never be left propped open. We enjoy competent and professional support from the Baskin Engineering Lab Support Group. Immediately report any problems pertaining to the laboratory to them; they can also be consulted for parts you may need.

Evaluation:
Since the lecture and laboratory are very closely related, you must pass both of them to obtain credit for the course. If you fail either one, that grade will be assigned to both sections.

1. Lecture:
   Homework ……. 30%
   Midterm …… 35%
   Final Exam …….35%

2. Laboratory:
   See separate lab course assignment sheet issued during the first laboratory.

Academic Integrity:

The student-instructor relationship is based on imputed trust. Violations of this trust by deceptively offering the work of others as your own, cheating on examinations etc. will result in formal charges of academic dishonesty being brought against you.

Students who qualify for DRC accommodations need to submit appropriate paperwork early in the quarter.