Course Title: Advanced Circuit Design

Class Information: Spring 2020
Class time: 2:50-4:05 Tuesdays and Thursdays
Location: Votey 334

Instructor Information: Dr. James Kay Votey 373
Phone: (802) 656-0734
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Office Hours: Monday 3:30 to 4:30 Thursday 4:15 to 5:15

Prerequisite: EE121 Electronics II

Course Description: This course covers both analog and digital circuit applications. Possible topics include analog to digital converters, optical isolators (linear and non-linear), comparators, voltage to frequency converters, analog switches, voltage references, precision dividers, analog multipliers, multiplexers, phase locked loops, power supply monitoring circuits, instrumentation amplifiers and pulse width modulators. Detailed performance characteristics of op-amps, including offset voltages and currents, input noise characteristics, slew rate and bandwidth will also be covered. The course will be a mix of lab demos and lectures. The goal is to provide students with experience applying off the shelf integrated circuits to engineering problems.

Course Objectives:

1. Understand the functions and performance of a wide variety of commercially available electronic components.
2. Gain a detailed understanding of the functional blocks in a practical high precision data acquisition system.
3. Gain sophistication in creating circuit designs using a variety of commercially available components
4. Understand how to perform functional decomposition of requirements to create circuit and sub-circuit level requirements.

5. Gain experience in troubleshooting prototype circuits, including dealing with the non-idealities of circuit models and parasitic components.

Course Culture: Respect yourself and all others. I can't work on a problem or issue with the class if I do not know about it, so please let me know of any issues that come up.

Text and lab components: There will not be a text in the course as we will be using instructor notes and manufacturer's web sites. Students are required to purchase a lab kit containing a variety of electronic parts. I recommend you order the parts as soon as practical. The parts you need are included in the ADALP2000-ND parts kit. You can order it from Digi_Key. I have included a link below. Please email me if you are having any difficulty purchasing the kit.

https://www.digikey.com/products/en?keywords=ADALP2000-ND

Grading: There will be 6 to 9 lab based assignments with reports that will be worth a total of 51% of your final grade. The lab assignments will be a mix of team and individual based projects. There will be three take home exams worth a total of 24% of your grade, these will be assigned at the beginning of February, March, and April. There will be a team based final project worth 25% of your grade. Tentatively the final project will consist of implementing a precision data acquisition system, but this is subject to change based upon the actual topics covered in the course.

Topics:

1. Analog switches. (1 week)
2. Switched capacitor networks. (1 week)
3. Current Sources (1/2 week)
4. Operational and instrumentation amplifiers. (ECG lab) (2 weeks)
5. Voltage References (1 week)
6. Digital to analog convertors (1 week)
7. Analog to digital convertors (including voltage to frequency convertors) (2 weeks)

8. DC to DC convertors (If time and interest allow) (2 weeks)
9. Phase Locked Loops (If time and interest allow) (2 weeks)
10. Synchronous demodulation (If time and interest allow) (2 weeks)
11. Precision data acquisition systems. (3 weeks)

The total duration of all these topics is 17.5 weeks, so some topics will be eliminated. Students will be surveyed (through a blackboard assignment) during the first week to determine the level of interest in each topic.

General:

The instructor posts all lecture notes, assignments, solutions, and additional material at the Blackboard (Bb) site for this class. This can be found at: https://bb.uvm.edu

The course will be organized in an active learning format and will require outside readings and exercises to be completed prior to the scheduled classes. In addition it is expected students will need to use the lab during non-scheduled times. Non-scheduled lab access will be granted to students after completion of the safety overview and training.

The class will be broken into modules based on the topic areas. Typical class flow will consist of a discovery class meeting where the students will work through a set of lab exercises on a new topic. The following class will typically be a mix of lecture and demonstrations on the new topic, followed by a report to be submitted by the students at the next class period. This format will be modified in the number of classes assigned to each activity based on the topic.

The take home exams will be problems sets on the topic areas. They will be a mix of theory and direct application of specific circuits. You will be expected to extract the needed information from supplier datasheets for these exams. They will be structured to build your insight and intuition for circuit design.

Attendance: Attendance is a critical aspect of this course. Students are expected to attend all class meetings. Given the hands on and active learning nature of this class it will be difficult to

succeed without attending the classes. The instructor should be contacted prior to any absences. If an absence is approved the instructor will provide the student with an out of class assignment to substitute for the material covered during the class period.

Academic Integrity: Students are expected to behave in an ethical fashion. This includes proper citations in written work, and respect for the intellectual property of others. UVM's policy on academic integrity is clearly defined and can be found at http://www.uvm.edu/~uvmppg/ppg/student/acadintegrity.pdf

ADA: In keeping with University policy, any student with a documented disability interested in utilizing accommodations should contact SAS, the office of Disability Services on campus. SAS works with students and faculty in an interactive process to explore reasonable and appropriate accommodations, which are communicated to faculty in an accommodation letter. All students are strongly encouraged to meet with their faculty to discuss the accommodations they plan to use in each course. A student's accommodation letter lists those accommodations that will not be implemented until the student meets with their faculty to create a plan. Please visit the following site for contact information. www.uvm.edu/academicsuccess/student_accessibility_services

Religious Holidays: Students have the right to practice the religion of their choice. Students should submit in writing to the instructor by the end of the second full week of classes their documented religious holiday schedule for the semester. An arrangement could then be made to make up the missed work.

Alcohol/Cannabis: As a faculty member, I want you to get the most you can out of this course. You play a crucial role in your education and in your readiness to learn and fully engage with the course material. It is important to note that alcohol and cannabis have no place in an academic environment. They can seriously impair your ability to learn and retain information not only in the moment you may be using, but up to 48 hours or more afterwards. It is my expectation that you will do everything you can to optimize your learning and to fully participate in this course.

ABET Matrix:
0 - little or no contribution
1 - moderate contribution
2 - high level of contribution

- *Outcome (1)*: An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
Contribution: 2
- *Outcome (2)*: An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
Contribution: 2
- *Outcome (3)*: An ability to communicate effectively with a range of audiences.
Contribution: 1
- *Outcome (4)*: An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
Contribution: 0
- *Outcome (5)*: An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
Contribution: 2
- *Outcome (6)*: An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
Contribution: 2
- *Outcome (7)*: An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
Contribution: 2
- *EE Criterion (A)*: The curriculum must include probability and statistics, including applications appropriate to the program name; mathematics through differential and integral calculus; sciences (defined as biological, chemical, or physical science); and engineering topics (including computing science) necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components.
Contribution: 0
- *EE Criterion (B)*: The curriculum for programs containing the modifier “electrical,” “electronic(s),” “communication(s),” or “telecommunication(s)” in the title must include advanced mathematics, such as differential equations, linear algebra, complex variables, and discrete mathematics.
Contribution: 0