Chemistry 492 — Basic Analog Electronics and Instrument Design — Fall 2015

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Lecture/Lab: TF 12-1:50 pm

Text: Reference books will be available and should be used as necessary.
For example,
Diefenderfer, A.J *Principles of Electronic Instrumentation*, 3rd Ed.
Horowitz and Hill, *The Art of Electronics*
ARRL, *Amateur Radio Handbook*
Carr, Electronic Circuit Guidebook: OpAmps
Carr, Electronic Circuit Guidebook: Oscillators
Assorted handouts.

At-a-Glance Information

OFFICE HOURS	
Tuesday	11a-12p
Wednesday	2p-3p
Friday	9:30a-10:30a
Email: All day until 10:00pm	

Student Learning Outcomes

As aligned with the Chemistry Program Learning Outcomes, at the completion of this course every participant will…

- understand the design charactistics of and be able to build practical passive and active analog circuits including, at least, resistor/capacitor/inductor networks, transistor and operational amplifier filters and amplifiers, and timer/waveform generators.
- utilize combinations of passive and active circuit designs to build 3 working "mock-up" instruments which demonstrate the functional characteristics of electronic instrumentation used in the laboratory.
- demonstrate each mock-up instrument to the other participants and instructor of the course including details on component selection and design rationale.

Goals

Electronics has developed explosively over the last 50 years. The overall goal of this course is to provide students with a sufficient understanding of the principles, laws, and theories of basic analog electronics to partially eliminate the mystery of the internal workings of the chemical instrumention ubiquitous in the laboratory. Participants in this course will gain the competence to read schematic diagrams of electronic circuits, assemble the circuit on a design breadboard, characterize and modify the operating circuit using standard test equipment available to the electronics technician, troubleshoot non-working circuits, and design and build their own simple but useful working circuits.

in addition to these goals, the specific goals are that every participant will…

- ✓ recognize and appreciate the technical challenges faced by instrument designers.
- ✓ be able to use properly the common electronic test equipment.
- ✓ learn the basic steps in troubleshooting a nonfunctioning instrument.
- ✓ understand that the success of any of any design may depend upon team of technicians working together to solve the problem.
- ✓ have a basic operational knowledge of analog electronics which transcends the quick rate of obsolescence of specific electronic components.

The theoretical and practical aspects of each unit will be studied almost entirely through a hands-on approach in a highly cooperative environment. Practical learning of electronics comes from building proficiency in each more-advanced topic upon a base of mastered concepts while frequently returning to the basics for validation.

Upon successful completion of this course every course participant should be able to:

- ✓ understand the principles underlying the operation of passive and active electronic components.
- ✓ describe the basic operational parameters for common passive and active circuits and make measurements and calculations to validate these parameters.
- ✓ carry out design, assembly, testing, and characterization of common useful circuits similar to those found in modern electronic instrumentation.
- ✓ use the tools of the electronics technician properly and safely.
- ✓ disseminate their designs and results to others in such a way that their work can be duplicated by anyone with similar training.

Relationship to the Seaver College Mission

From The Mission of Seaver College of Pepeprdine University: "Seaver College exists to provide a link between the knowledge and wisdom of the past and present with the challenges of the future. The college is essentially a community…[of] teachers committed to a life of instruction and scholarship [and] students preparing to assume responsible roles in contemporary society…."

This course is designed to provide the framework on which hangs a portion of the body of basic knowledge regarding analog electronics and the design of chemical instrumentation, allowing the perceptive participant to glance into the richness of electronic circuit design, and to provide the foundation for further studies in the field. Over the course of the semester, the successful participant will develop new and expand upon existing skills in critical thinking, mathematics, and applications of skills learned previously in chemistry and physics. Since courses in the chemistry major are by their very nature experimental, honesty and integrity in the acquisition and analysis of data is at the very core of the scientific process. It is part of our role as practicing scientists to defend the nature of scientific discourse and to expose pseudoscience and scientific dishonesty.

Attendance

You must attend class. While most of the information can be obtained from the text and handouts, lecture will help to simplify most of the concepts and help in identifying analog design shortcuts, etc. Being an active and cooperative-learning course, missing any in-class time affects the entire group. Every missed day will result in a 2% reduction of your course grade. Exceptions to this policy are made on a case-by-case basis.

Ample opportunities exist to work on your circuits at other times outside of class, if you are not finished by the end of the period. This offer of extra time does not extend to those who leave with the intention to come back later to finish – it is only offered to those who actually work during class time and cannot complete the assignment. **If you miss more than 3 classes, a grade of 'F' will be assigned.**

Homework

There is a quantity of homework which will need to be completed for understanding the circuits under study. Fortunately, most of the homework is completed by merely setting up the circuits, testing, and characterizing them. Some chapter problems will be assigned and may have answers and thus work well for study and review.

Office Hours Office hours are posted. Attending posted office hours are preferred but if you can't make a posted hour you can make an appointment or even just try dropping by. Don't hesitate to get help if there's a problem. If you are doing unassigned problems or trying unassigned circuits to gain proficiency, I will go over the problems with you, if you wish. I will even try to answer questions *via* e-mail. The average maximum time for reply is typically 3-6 hours during the day and 6-12 hours past 9:00 p.m.

Lab The bulk of this course is lab work, some of which you may do at your convenience. If you are careful, methodical, and take good notes, you will be designing your own useful analog circuits by week 5 or 6. You will need to turn in for credit the schematic of every circuit you build with the associated currents, voltages, waveforms, etc. which you measured. Tables of expected results and measured results are both informative and useful later. **Use of a laboratory notebook for results is required and the lab notebook will be graded.** The format of the laboratory notebook is similar to that of which are familiar from other chemistry courses. You may turn in a Xerox copy of the book pages if you like.

This instructor encourages every participant in this course to explore circuits beyond those assigned. Several reference books will be available for use. If you are trying new designs, please make certain that there are no direct power-supply-to-ground connections (*i.e.* short circuited power supply connections) and that all appropriate load ratings are observed for "active" components (*e.g.* transistors and opamps).

Examinations and Quizzes Yes, there will be exams. All will be take-home and cover all material assigned in lecture, reading, and laboratory activities. There are two scheduled comprehensive exams and a cumulative final will be given. Exams will cover material up to the lecture prior to the exam. No exam score will be dropped. Exams are scheduled to be assigned at the end of each course module.

Occasional quizzes will also be given reviewing material covered in readings and class. Quizzes will be given at the beginning of class at the instructor's discretion.

Grading Your course grade is broken down as follows:

2 tests	=	21% each
Final Exam	=	23%
Homework	=	10%
3 Projects	=	46%

		100%

Curving You may be accustomed to being "graded on a curve" in some of your classes. What is usually meant by this is that if an average test score is not at an arbitrarily determined level, the teacher will adjust the scores or grade range-breaks so that the average does meet this numerical criterion. It makes little statistical sense (on which a *curve* depends) to curve a class of less than 100 students. A curve also tends to promote unhealthy competition which interferes with an atmosphere of cooperativity and friendly competition. In this course your grade will be based on your final course average and determined by a fixed scale:

Course Average	Grade
100-94%	A
90-93%	A-
87-89%	B+
84-86%	B
80-83%	B-
77-79%	C+
etc.	

Scores on the borderline will be handled individually by the instructor. *Borderline* is defined as being 0.49 percentage points from the next highest grade.

Equipment

You will be using and sharing the Heathkit™ and Elenco™ breadboards and other breadboarding systems, as well as electronic test equipment, voltage and waveform generators, and many small electronic components. It is essential that you take care of the equipment (of course) and should any component or piece of equipment break, burn out, or get damaged in any way that you tell the instructor. An accident is not negligence if it is truly an accident **AND** it is reported immediately.

Please take care to keep components and equipment neatly stored away when not in use. Tools must be stored in such a way as to prevent theft (a common problem for this laboratory). You are encouraged (but not required) to purchase your own needle-nose pliers (small, for fine work), small diagonal wire cutters, small screwdriver set, fine forceps, and digital multimeter (DMM with at least voltage, resistance, and current measurement capabilities).

Projects

Participants must design, assemble, and characterize 3 different working instruments. The quality of the instrument does not have to be at commercial production level but must demonstrate the basic principle of the commercially available instrument. Ambitious students may construct a single, more complex instrument in lieu of the required 3 instruments. This instrument must use at least 3 subsystems which must be interfaced for successful operation of the overall system. The project must be approved by the instructor.

Participants may elect to pursue more than the minimum required designs to improve their knowledge of electronic design (see A Note on Grades).

Projects will be graded on quality, function, difficulty, and neatness. Moving the circuit to a printed circuit board is not required. A photograph (or multiple photographs) of each completed project must be submitted with each circuit. The use of circuit drawing software, such as ExpressSCH (freeware), is encouraged but not required.

A Word On Sorority, Fraternity, Sports, etc.

Extracurricular activities such as debate, volunteering, community service, sororities, fraternities, athletics, drama and other artistic endeavors, etc. are important parts of your total education at Pepperdine. However, these activities require a very significant time commitment. **It is your responsibility to keep up in class while involved in extracurricular activities.**

Plagarism and Cheating

Fortunately, in all likelihood, no one in this class will be subject to this paragraph. Plagiarism and cheating are professionally and ethically wrong. There exists a fundamental difference between working cooperatively (*e.g.* working together with friends or in a study group on homework problems which this instructor not only approves of but also encourages) and simply copying someone else's work. Cheating on an exam or plagiarizing the work of others in class or in the scientific community is an offense of considerable magnitude. Students suspected of cheating or plagiarism will be referred to the University Academic Ethics Committee. *It's not worth it – trust me on this!*

Cellular Telephones and Internet Messaging

If you bring a cell phone with you to class, please turn it off or deactivate any audible signals before class starts. It is very distracting (and stunningly inconsiderate) to have incoming calls during class time. Your course grade will be affected if your phone audibly rings during class. Some like to use their computer to take notes in class – a practice which your professor does not discourage. There is a strong temptation to accept internet messaging requests during class – a practice which your professor strongly discourages.

Important Information That Doesn't Fit Elsewhere

The incomplete grade (I) will be assigned only in cases of an extreme emergencies and only in the last 3 weeks of class (after Exam 3 but prior to the final exam). According to university policies, the grade of incomplete will not be assigned to allow extra time for a student to improve their grade but, rather, only in the case where an emergency prevents a student from completing a course's culminating assignments and exams. Supporting

documentation is required. Should the need arise for non-emergency situations, there are 3 opportunities during the semester to withdraw from this course.

There is no "extra credit" beyond that which is available to every student in class. No exceptions; please, don't ask. Consider the rationale: If someone hasn't yet earned the available credit, how then can they be eligible for "extra credit"?

Pet Peeves

There are really very few things that bother this professor during class time. An open and friendly classroom that allows for discussion and dialog is desired and, even, encouraged. However, there are a few behaviors that can elicit a strong and negative response. The chances of getting along with this and other professors are greatly increased if you avoid…

…continued chatter past the scheduled start of class time.
…talking when the instructor is talking or another student is asking a question or speaking.
…habitually arriving late to class.
…chronically leaving and returning to the classroom during lectures.
…making any noise while chewing gum.
…eating loud food or slurping through a straw during lectures.
…failing to laugh at your professor's jokes regardless of their humorous quality.

Saving Graded Material

It is your responsibility to save all graded materials (exams, homework, etc.) for this class. As per university policies, all grade disputes must be settled by the midpoint of the next non-summer semester which immediately follows this course.

Counseling Center and Disability Services

Students who feel that they may suffer from "test anxiety" or other academic obstacles despite exercising reasonable study and social habits may benefit by speaking to one of the staff in the Counseling Center.

Any student with a documented disability (physical, learning, or psychological) needing academic accommodations should contact the Disability Services Office (TCC264, x6500) as early in the semester as possible. All discussions will remain confidential. Visit www.pepperdine.edu/disabilityservices/ for additional information.

Course Evaluations

At the end of every course, each student has the opportunity to evaluate the course and the professor. This input is valuable for every faculty member so that they can discern both what is being well-presented as well as what may need to be modified to improve the course. Course evaluations are completed on-line near the end of the semester.

Your professor in this class appreciates your critique, both good and bad, and believes that you do not need to be motivated to complete your evaluation by receiving "extra credit" points or other intangible rewards.

Some Gentle Advice

What and how you write in all media forms reflects on you and your professionalism. There exists different liguistic cultures in different "worlds". Text messaging a friend on a cell phone or in internet messaging is a different world than emailing a professor requesting help and letters of recommendation or a prospective employer about a job. The rules of etiquette are different in different arenas. For example, "chatspeak" (when used correctly) is a fast and phonetic way to transfer information back and forth on a cell phone. Chatspeak, however, has no place in professional communication and simply appears as laziness. As a member of a community of professionals, let your communication style reflect on your professionalism. In professional communications, take the time to use good grammar and punctuation. Use proper honorifics and salutations. All of your faculty will appreciate it and will usually respond to you more quickly and respectfully.

Intellectual Property Statement

Course materials prepared by the instructor, together with the content of all lectures and review sessions presented by the instructor, are the property of the instructor. Video and audio recording of lectures and review sessions without the consent of the instructor is prohibited. Unless explicit permission is obtained from the instructor, recordings of lectures and review sessions may not be modified and must not be transferred or transmitted to any other person. Electronic devices other than calculators (e.g., laptops, cell phones, PDAs,

calculators, and recording devices) are not to be used during lectures or exams without prior permission of the instructor.

Parting Note If you are having any problems in the class, do not hesitate to come see me (this applies equally to out-of-class problems). I will attempt to accommodate the best I can if you need help outside of office hours.

Some Important Dates

September 4	Last day of add/drop period; last day 100% refund period
September 7	Labor Day holiday
September 14	Last day to change CR/NC status
October 2	Faculty Conference; no classes meet
October 26	Last day to withdraw with a grade of W
November 25	Thanksgiving holiday; no classes meet
December 4	Last day to withdraw with a grade of WP/WF
December 16	Final exam: Wednesday, 7:30-10:00 am

Disclosure Statement Required by the State of California

Warning: Natural Science's laboratories contain and certain class experiments or procedures will expose you to chemicals known to the state of California to cause cancer, birth defects, and other reproductive harm at levels which require a warning. For more information, contact your instructor or the Office of Regulatory Affairs at extension 4702.

So, there.

A Note On Grades

Most students believe their course grade is important, and rightly so. However, many will try to "earn" an 'A' with a minimum amount of work, or with procrastination, cramming, etc., and perhaps even cheating. Some people think that grades are comparable to wages; that is, the more one works, the higher the grade should be regardless of the level of mastery. One goal of this instructor is to help you make the attainment of knowledge (not just chemistry) and its wise use your ambition. When you make learning *personal* and not simply a short-term goal to get you to the next class, job, etc. then the grade will have a new significance and be a by-product of (rather than) the goal. With this in mind, the guidelines for the definition of the course grade is outlined below. These will be the criteria used to determine your course grade:

A is the highest academic grade possible. This honor is **not** automatically given to a student who ranks highest in the course, but is reserved for accomplishment that is truly distinctive and demonstrably outstanding. It represents a superior mastery of course material and is a grade that demands a very high degree of understanding, originality, and/or creativity. Further, the student is characterized as one who takes initiative in seeking new knowledge outside the formal confines of the course.

B is a grade that denotes achievement considerably above acceptable standards. Good mastery of course material is evident and student performance demonstrates a high degree of originality, creativity, or both. Student works well independently and often shows initiative. Oral and written analysis, synthesis, and critical expression is considerably above average.

C indicates a satisfactory degree of attainment and is the acceptable standard for proceeding to more advanced work in the field. It is the grade that may be expected of a student of average ability who gives to the work a reasonable amount of time and effort. This grade implies familiarity with the content of the course and acceptable mastery of the material. Student displays some evidence of originality, creativity, or both. Student works independently at an acceptable level and **completes all requirements in the course**, including attendance and participation.

D denotes a limited understanding of the subject, meeting only the minimum requirements for passing the course. It signifies work which in quality and/or quantity falls below the average acceptable standard for the course. Performance is deficient in analysis, synthesis, and critical expression and lacks in originality and creativity. This grade is insufficient to proceed to higher level courses in the discipline. For most students this grade is the result of insufficient devotion of time to the course.

F indicates inadequate or unsatisfactory attainment and a serious deficiency in understanding of material. This grade also indicates the student cannot work independently and/or fails to complete assignments. This grade is usually earned by students who do not attend class or devote sufficient time to study. This grade, like the 'D', is inadequate for proceeding to higher level courses in the field.

A Guide to Learning

The following taxonomy[1] summarizes the 6 levels of learning. Generally, it may be said that a student who wishes to master the material of a class will strive to reach level 6.

Notice that to move up in the learning heirarchy, a student will have, for example, mastered the language of the field and possess a knowledge-base of basic facts before they can select the correct formula to solve a problem given a list of data. A level 6 "thinker" will necessarily have mastered the lower levels to such an extent that they can call upon those tools as necessary to solve the problem at hand. It is suggested that one cannot effectively move to higher levels until lower levels have been adequately addressed.

1. **Knowledge** Language of chemistry, nomenclature, facts, memorization

2. **Comprehension** Qualitatively predict outcome of a reaction or process, summarize results, estimate a result

3. **Application** Use formulas to solve a problem (d=m/v, PV=nRT, etc.), apply and calculate, algebraic manipulation, explain and demonstrate

4. **Analysis** Gather and use experimental data to solve an assigned problem, present results in written or oral format

5. **Synthesis** Use prior knowledge to derive new knowledge, derive from known equations new and useful equations, utilize prior material learned in prior courses in current course, read the primary and secondary literature to obtain necessary tools for performing an experiment, independently design a new experiment or analysis, gather and use experimental data to solve a problem, write and speak clearly and accurately in the scientific style

6. **Evaluation** Examine data and results to distinguish quality from "noise", read the primary literature and rationally and critically discuss the results presented, predict the outcome of similar experiments

[1] This heirarchy is based on Bloom's Taxonomy of Cognitive Learning

SCHEDULE
(CHAPTERS ARE FROM DIEFENDERFER)

WEEK	TOPIC	CHAPTER
1	**Introduction**	
	Schematic Diagrams	
	Symbols	
	Conventions	
	Electronic Measurements	6
	DC voltage	
	DC current	
	Resistance	
	Voltage, Current, Resistance, Power	1
	DC Circuits	
	Current	
	Voltage	
	Resistance	
	Ohm's Law	
3	**Electronic Measurements**	6
	AC voltage	
	AC Frequency	
	Oscilloscope	
	Frequency Counter	
	AC Circuits	2,3,4
	Tuned Circuits (RC, LC, RLC)	
	Passive Filters	
4,5	**Semiconductors I**	5,7,8
	Diodes	
	half-wave/full-wave rectifiers	
	Transistors	
	Amplifiers	
5,6	**Semiconductors II**	9
	Operational Amplifiers (IC OpAmps)	
	Noninverting Amplifier	
	Inverting Amplifier	
	Follower Amplifier	
7,8	**Example Circuits**	10
	Active Filters	
	Active Rectifiers	
	Power Supplies	
	Modulation/Mixing	
	Oscillators	
9-15	**Design, testing, and construction**	

Participants must design, assemble, and characterize 3 different working instruments. The quality of the instrument does not have to be at commercial production level but must demonstrate the basic principle of the commercially available instrument. Ambitious students may construct a single, more complex instrument in lieu of the required 3 instruments. This instrument must use at least 3 subsystems which must be interfaced for successful operation of the overall system. The project must be approved by the instructor.

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