
Instructor: David Green
Office: RAC 128 Ext. 4355
E-Mail: david.green@pepperdine.edu (attachments accepted)
URL: seaver-faculty.pepperdine.edu/dgreen
Office Hours: Tuesday 11-12; Wednesday 2-3; Friday 9:15-10:15; email: all day until about 10:00 pm
Lecture: MWR 12-12:50 p.m. KSC 430
Lab: Thursday; 2 p.m.; KSC 430

Text: Skoog, Holler & Crouch, *Principles of Instrumental Analysis* 7th Ed
Skoog, West, Holler, Crouch *Fundamentals of Analytical Chemistry* (optional)

Lab text: Green, *Laboratory Manual to Accompany Quantitative Chemistry and Instrumental Analysis*

TENTATIVE TEST SCHEDULE

This schedule is subject to change due to unforeseen factors

Exam 1	Thurs, Feb 20
Exam 2	Thurs, Mar 27
Exam 3	Tue, Apr 28 10:30 am

Curiosity has its own reason for existing. One cannot help but be in awe when he contemplates the mysteries of eternity, of life, of the marvelous structure of reality. It is enough if one tries merely to comprehend a little of this mystery every day. Never lose a holy curiosity.

- Albert Einstein

STUDENT LEARNING OUTCOMES The specific *Student Learning Outcomes* aligned to the Chemistry Program *Learning Outcomes* is that at the successful completion of this course participants should be able to successfully solve a variety of multi-step problems using mathematical and descriptive algorithms and, specifically in the laboratory portion of the course, participants will be able to utilize analytical chemical instrumentation properly including: preparation of high accuracy standards, set the operating parameters of different instruments, and perform calibration and analysis.

OBJECTIVES The overall goal of this course is to provide students with a sufficient understanding of the principles, laws, and theories of analytical chemistry to enable them to successfully analyze samples provided using selected instrumental methods. The student should gain the competence to follow a standard procedure, operate the

instrument in a safe manner, collect suitable data, evaluate the reliability of the data collected, and report the results in an appropriate form as would be required of any competent laboratory technician.

While the major foci are on the principles and capabilities of selected analytical instruments in addition to their design and construction, the specific goals are that every participant will...

- ✓ recognize and appreciate the value of analytical instruments used, as well as their limitations, in the solution of selected problems faced by the technician.
- ✓ realize the existence of a variety of instrumental methods, each with its own particular use based on its capabilities and limitations.
- ✓ understand that the selection of one instrumental method, as being superior to another in the solution of a particular analytical problem, is based on such factors as sensitivity, time required, selectivity, purchase cost of instruments involved, etc.
- ✓ understand that the success of any of the instrumental methods used depends upon a working knowledge and control of the operating parameters associated with each instrument studied.
- ✓ have a basic operational knowledge of the internal design of the instruments studied.

The theoretical background of each instrument will be given in lecture. Emphasis on the operating parameters associated with each of the instruments studied will be provided in the laboratory. Operational details are covered sufficiently to provide an adequate understanding of the techniques used without being overwhelmed by details.

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

- ✓ understand the principles underlying the operation of each of the studied instruments and extrapolate that knowledge to other instrumental methods.
- ✓ describe the operational parameters for each of the analytical instruments studied.
- ✓ carry out calibration of instruments, preparation of a sample for analysis, safe handling of the sample during the analysis, and proper disposal of the sample after completion of the analysis.
- ✓ use techniques for recording and evaluating analytical data derived from instruments.
- ✓ solve a variety of numerical problems dealing with the analysis of samples using the various instrumental methods studied.
- ✓ appropriately report the results of a given analysis.
- ✓ write in scientific format reports of the theory, experimental method, and results of an analysis.

**RELATIONSHIP TO
THE SEAVER
COLLEGE MISSION**

From The Mission of Seaver College of Peepurdine 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 significant portion of the body of basic chemistry knowledge, allowing the perceptive participant to glance into the richness of the microscopic world from a macroscopic point of view, and to provide the foundation for further studies in the sciences. Over the course of the semester, the successful participant will develop new and expand upon existing skills in critical thinking, mathematics, chemical analysis, and the scientific method. Since chemistry is by its very nature an experimental science, 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 Generally, attendance records will not be rigorously kept. However, every 2 noted unexcused absences will result in a reduction of your course grade by 1%. Since the content of exams and homework problems is often covered in lecture, missing class is not advised. Tardiness is disruptive – please try to be to class on time. The instructor reserves the right to consider a tardy arrival as an absence. If you *must* leave early, advise Dr. Green before class starts. Attendance, as well as attitude, plays an important role in the subjective portion of the course grade, as well.

***We are what we consistently do; excellence...
therefore, it is not an act but a habit. - Aristotle***

HOMEWORK Homework will be assigned as we go. Homework will be due on the assigned date. Please try not to turn in work late. Much of the homework assigned will not be graded. You should do more than the assigned problems to do well in this course. You must keep up with reading. Do not put off reading the text. Lecture and text will complement each other – some important information will be found in one but not the other.

QUIZZES Occasional unannounced short quizzes may be given during the semester so that you can track your progress and improve on deficiencies if necessary. If you miss a quiz for any reason, it cannot be made up.

EXAMINATIONS Three exams are scheduled. No exam may be taken early or late. No exam will be dropped. Each test counts 100 points and are the most significant contributions to your course grade. If you score 15 points below the mean on two tests, please see Dr. Green concerning your status in the course. There is no mechanism built into the class to make up a missed exam. Make arrangements early if you will be missing an exam because you are a participant in a school sponsored event. In the event of an illness – with documentation from a physician or the University Health Center – contact the course instructor as soon as is practical to make appropriate arrangements. A tentative exam schedule is given below.

Occasional unannounced short quizzes may be given during the semester so that you can track your progress and improve on deficiencies if necessary. If you miss a quiz, it cannot be made up.

DEADLINES Deadlines and due-dates are not negotiable. It is the responsibility of every student to meet due date deadlines., Quizzes and exams must be turned in when called for. Competency, mastery and success in any course (or career choice) is defined not only by the correct answer but by a person's alacrity, facility, and finesse at completing timed tasks.

GRADING Your course grade is broken down as follows:

3 tests	=	27% each
Homework	=	10%
Discretionary	=	9%

		100%

It is important to remember that grades are not wages. You will not be graded on how hard you work – you will be graded on mastery of the assigned material. 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+
74-76%	C
70-73%	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.

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 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.

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.

To the scientist, the universe is a toy box full new toys and gadgets to be played with and disassembled just to see how they work.

- anonymous

A Word On DEAD WEEK Contrary to common belief, the last week of classes is not reserved for review, partying, etc. There will be lecture on new material and homework will be due. There might be review during that week as well.

A Word On Sorority, Fraternity, Sports, SongFest, etc. Extracurricular activities such as 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.** This professor encourages you to make a decision now whether academics or co-curricular activities will take priority if your mastery of the material in this or other courses begins to suffer. Making this decision sooner is unquestionably better than later.

LABORATORY You are required to attend prelab discussion and laboratory at the assigned time. The lab is scheduled for 4 hours. You will undoubtedly, at times, take longer than 4 hours. You will have some opportunity to work on your laboratory assignments at other times as well if you are not finished by your assigned lab time. 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 their assigned lab time and cannot complete the lab on time. I will give time-saving hints when they are available and appropriate (and don't adversely affect the analysis or experiment). **If you miss more than 3 labs, a lab grade of 'F' will be assigned.** Please don't miss lab. **The laboratory grade is independent of the course grade.**

More analyses will require formal reports than in *Quantitative Chemistry*. For analyses and experiments which require a formal report, you will have 2 weeks from the time you complete an analysis to turn in the analysis report without penalty. If you turn the report in within 1 week of the day the analysis is assigned, an additional 10% will be added to the report score. If you turn in the report after 2 weeks, a non-negotiable 10% late penalty will be assessed per day (or any part thereof). It is essential that you do not get behind in turning laboratory reports!

Since the laboratory complements the lecture, you will be responsible for laboratory material in lecture.

PLAGIARISM 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!*

One purpose of a liberal arts education is to make your head a more interesting place to live inside of for the rest of your life.

- President McPherson, Bryn Mawr College

**CELL PHONES
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 colossally inconsiderate) to have incoming calls during class time. ***Your course grade will be affected if your phone audibly rings during class.*** Please read that previous sentence again. Some people like to use their computer to take notes in class – a practice which your professor does not discourage. There is a strong temptation to engage in social media during class – a practice which your professor strongly discourages.

**OTHER 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.

The most exciting phrase to hear in science, the one that heralds new discoveries, is not 'Eureka!' (I've found it!), but 'That's funny...'
-- Isaac Asimov

**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 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"?

**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.

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.

Knowledge, and understanding, are wild things, to be hunted down and subdued.

Ignorance, stupidity and superstition are infectious, treatable conditions; but their successful treatment requires the cooperation of the patient.

*- John N. Cooper, Professor of Chemistry
Bucknell University*

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.

Guide to Learning

The following taxonomy¹ 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 hierarchy, 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

Generally Observed Student Characteristics

(Adapted from John H. Williams, *The Teaching Professor*, 1993, pp 1-2)

The "A" Students...

Attendance ...have nearly perfect attendance.

Preparation ...are prepared for class. Their attention to detail is superb and they usually read the material prior to class.

Curiosity ...show a high level of interest in the subject matter whether they actually like the subject or not. They look up or search out answers to topics that they don't understand. They often ask interesting questions or make insightful comments.

Retention ...are able to retain new material and consciously connect past learning to the present.

Attitude ...have an attitude that displays both the determination and self-discipline required for success. They also show initiative and do things without being told.

Talent ...possess a special talent. It may be exceptional intelligence and insight or it may be unusual creativity, organizational skills, commitment and perseverance - or a combination thereof. These gifts are evident to the professor and usually to the other students as well.

Results ...make the highest grades on tests and their work is generally a pleasure to grade.

The "C" Students...

¹This hierarchy is based on Bloom's Taxonomy of Cognitive Learning

- Attendance** ... put other priorities ahead of academic work and may miss class frequently.
- Preparation** ...prepare their assignments consistently, but in a perfunctory manner. Their work may be sloppy or careless and at times is incomplete or late.
- Attitude** ...are not visibly committed to the class. They participate, if at all, without enthusiasm and their body language often expresses boredom.
- Talent** ...vary enormously in talent. Some have exceptional ability, but show undeniable signs of poor self-management or bad attitude. Other are committed and diligent, but are simply average in academic ability.
- Results** ...obtain mediocre or inconsistent results on tests. They have some concept of and familiarity with the material, but clearly do not show mastery of the subject matter while insisting otherwise.

I cannot teach anybody anything, I can only make them think.

-Socrates

Some Important Dates

1/17/2020	Last day of add/drop period
1/20/2020	Martin Luther King Day
1/28/2020	Last day to change CR/NC status
3/2/2020	Spring Break
3/16/2020	Last day to withdraw with a grade of W
4/17/2020	Last day to withdraw with a grade of WP/WF
4/28/2020	Final exam: 10:30am

There is a theory which states that if ever anybody discovers exactly what the universe is for and why it is here, it will instantly disappear and be replaced by something even more bizarre and inexplicable. There is another theory which states that this has already happened.

- Douglas Adams, "The Hitchhiker's Guide to the Galaxy"

Instrumental Analysis

Chapter Schedule

This schedule gives the minimum content we will cover in each chapter. The texts from *Quantitative Chemistry*² and *Instrumental Analysis*³ will be used in this course; however, all course content can be obtained from the *Instrumental Analysis* text.

Chapter (SHN)	Chapter (SWHC)	Coverage
1	1	Introduction Classification of analytical methods Instrumental methods Basics of selecting a method The "schematic instrument"
6	24	Introduction to Spectroscopy Electromagnetic radiation Quantum mechanical considerations Absorption and emission Diffraction, dispersion, refraction, reflection
7	25	Instrumentation for Spectroscopy Sources Monochromators Sampling Detectors Signal processing
13,14,15	25,26,27	UV-Visible Molecular (Electronic) Spectroscopy Terms Theory Quantitative and qualitative aspects Applications
8,9	28	Atomic Spectroscopy Terms Theory Instrumentation Sampling Atomic absorption/emission spectroscopy Inductively coupled plasma spectroscopy
16,17		Infrared Spectroscopy Theory Instrumentation (FT vs. scanning) Sampling Spectral interpretation
19		Nuclear Magnetic Resonance Spectrometry Theory Instrumentation Applications Spectral interpretation
26,27,28	30,31,32	Chromatographic Methods (Chem340 Redux) Classification Rate theory and solute migration Column efficiency van Deemter relationship Gas chromatography Instrumentation Applications HPLC Instrumentation Applications

²Skoog, West, Holler, Crouch *Fundamentals of Analytical Chemistry* (SWHC)

³Skoog, Holler, Nieman *Principles of Instrumental Analysis* (SHN)

Time Permitting

22,23,25	15,16, 18,19,21	Electroanalytical Chemistry (Redux) Electrochemical cells Electrode and Cell potentials and equilibrium considerations Reference and indicating electrodes Electrochemical current Electrochemical methods Potentiometry Direct and indirect potentiometric determinations Sources of electrochemical potential Voltammetry Normal and pulse polarography Cyclic voltammetry
20		Mass Spectrometry Theory Instrumentation Sources Detectors
5		Measurements, Signals and Noise Terms Sources of noise Noise reduction Signal enhancement Signal processing Sensitivity The "Analytical Triangle"

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.