Syllabus

Department of Chemistry

FCH 511 – Graduate Studies

Atmospheric Chemistry

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SYLLABUS

FOR

Environmental Chemistry II
(Atmospheric Chemistry)

FCH 511/611
Fall 2010

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Acknowledgments

Many elements of this course guide are based on the ones I developed for FCH 360 and 361. The inspiration for these course guides come largely from Chuck Spuches of the Instructional Development, Evaluation and Services Office here at SUNY-ESF. Some ideas are derived from Dan Apple of Pacific Crest.

Contents

Basic Course Information

Class Time T Th 12:30-1:50
300 Bray Hall

Instructor Dr. Ted Dibble
421 Jahn
470-6596
tsdibble@syr.edu

Office Hours drop in

Required Text Seinfeld, J. H. and Pandis, S. N. Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, 2nd Edition, 2006, at book stores and online.

Relationship between FCH 511 and 611

FCH 511 is intended for MS students, and FCH 611 for PhD students. While the lecture material is the same, extra Homework Problems, Projects, and Exam Questions are required of PhD students.

Course Grade determined by:	
Exam I	20%
Exam II	20%
Final Exam	30%
Homework/Class Work/Projects	30%

Grading Scale		
	85 -100%	at least an A-
	75 - 84%	at least a B-
	65 - 74%	at least a C-
	55 - 64%	at least a D

"at least" means the instructor may make the scale easier than the above, but will not make it any harder.

Exams (different requirements for FCH 511 vs 611)

Exam I Thursday, Oct 7 - Tuesday, Oct. 12
(Structure and Transport, Stratospheric Chemistry)

Exam II Thursday, Nov, 18 - Tuesday, Nov. 23
(Tropospheric Chemistry)

Final Exam Thursday, Dec, 9 - Friday, Dec. 17
(Aerosols, Climate change, and comprehensive)

All exams are planned as take-home exams. All exams will include both numerical problems and conceptual questions. FCH 611 students will be required to earn an extra third of their exam points from conceptual questions that require explaining deep connections between more than one of the central ideas of the course.

Homework Exercises

Some *Exercises* are assigned to accompany the reading. These are mostly straightforward questions and computations intended to help you build your understanding of the facts and concepts presented in class and in the text. Answers to these questions will be posted.

Homework Problems (different requirements for FCH 511 vs. 611)

To build your ability to apply these concepts to new situations you will also be assigned a variety of *Problems*. These may be calculations or conceptual, but will commonly require you to integrate multiple concepts or pieces of data or apply your knowledge to a new situation. A significant proportion of class time will be spent discussing the *Problems*. *Problems* will be turned in for grading. Answers will be posted.

Students in FCH 611 will generally have to answer one additional question (4 instead of 3) for each set of *Problems*. The extra problem will explore connections between multiple key ideas under discussion in the course, and will be more open-ended than other questions.

Projects (different requirements for FCH 511 vs. 611)

The due dates are listed on the Calendar. Project #1 (numerically calculating photolysis rates) is required of all students.

Projects #2 and #3 are required only of FCH 611 students. Project #2 involves kinetic modeling of a well-mixed gas-phase system. Project #3 centers around the exploration of the OZIPR program for air pollution modeling, and requires students to generate their own questions to investigate using OZIPR.

Class Work

I may start a class period by giving you a short assignment to do in class based on assigned *Exercises*. In addition, I will often have you work in class, alone or in groups, to answer more open-ended questions, or some of the *Problems*. Both types of assignments may be collected and graded.

Required Readings and References (* FCH 611 only)

2007 Technical Summary of the Intergovernmental Panel on Climate Change, Working Group 1 (http://www.ipcc.ch/publications_and_data/ar4/wg1/en/contents.html)

* Barker, J. R., Ed. Progress and Problems in Atmospheric Chemistry, 1995. Chapters 4 and 14. **Moon QC879.6 .P735 1995**

Finlayson-Pitts, B. J. and Pitts, J. N., Jr. Chemistry of the Upper and Lower Atmosphere, **Moon RESERVE QC 879.6 .F57 2000**

* Odum, J. R., et al., The Atmospheric Aerosol-Forming Potential of Whole Gasoline Vapor. *Science* 4 April 1997: 96-99.

* Thornton, J. A., et al. Ozone production rates as a function of NO_x abundances and HOx production rates in the Nashville urban plume., *J.Geophys. Res*., 107, 4146, (2002).

Sander, S. P., et al**.,** Chemical Kinetics and Photochemical Data for Use in Atmospheric Studies, Evaluation #15, 2006 JPL Publication 06-02. (http://jpldataeval.jpl.nasa.gov/download.html)

Schedule

Class	Date	Reading	Assignment
1	Aug 30		
2	Sep 2	1.1-7, 2.1, 2.3-4, 2.6, 5.10	HW #1 Exercises
3	Sept 7	4.1-10	HW #1 Problems
4	Sept 9	3.1-4	HW #2 Exercises
5	Sept 14	2.3, 2.5-6	HW #2 Problems
6	Sept 16	5.1-5.6	HW #3 Exercises
7	Sept 21	4.1-4.6	HW #4a Exercises
8	Sept 23	3.5, 4.9-4.10, 6.14	HW #4a Problems
9	Sept 28	2.5, 2.7, 3.5, 5.7-8	HW #4b Exercises
10	Sept 30	5.9-11	HW #4b Problems
11	Oct 5	**Project #1 – due in class**	
12	Oct 7	Class work	**EXAM I handed out** (due Oct 12)
13	Oct 12	6.1-6.4	
14	Oct 14	6.5-9	HW #5 Exercises
15	Oct 19	6.10.1	HW #5 Problems
16	Oct 21	6.10-11	HW #6a Exercises
17	Oct 26		HW #6a Problems
18	Oct 28	FP+P 16.A.1	
19	Nov 2	16.1-2, 19.1, 25.1-2,4 FP+P 16.A.2-3	HW #6b Problems
20	Nov 4		HW #7 Exercises
21	Nov 9	FP+P 16.B-C	HW #7 Problems
22	Nov 11	2.7, 8.1-5	
23	Nov 16	**Project #2 - due in class***	
24	Nov 18	Class work	**EXAM II handed out** (due 11/23)
25	Nov 23	7.1-3, 3.7	
	Nov 25	**THANKSGIVING**	
26	Nov 30	6.13, 7.4-6	HW #8 Exercises
27	Dec 2	4.6, 23.1-8	HW #8 Problems
28	Dec 7	24.1-2, 24.7-8	HW #9 Exercises
29	Dec 9		HW #9 Problems

Final Exam sent to students 12/10/10, due 12/20/10
Project #3 due December 20, 2010*

* FCH 611 students only

Personal Statement

I am in my fifrteenth year at ESF, and my twelfth year teaching FCH 511 (Environmental Chemistry II). I have done a lot of research on radical chemistry important in the atmosphere. My research as a postdoc focused on degradation products of CFCs (Freons) and their substitutes. Since coming to ESF, I have focused on larger organic radicals, mostly alkoxy radicals (RO•) and peroxy radicals (ROO•). My primary research tools are those of a physical chemist.

You can see that my background is strongest in gas phase atmospheric chemistry; in that area my expertise is based largely on reading journal articles. By contrast, in the areas of modeling, aerosols, or global climate change, I will rely more heavily on reviews and textbooks.

Background and Purpose of the Course

This course is designed to give you an overview of atmospheric chemistry. This course, together with Environmental Chemistry I (Aquatic Chemistry) and Methods of Environmental Chemical Analysis, constitute the required environmental chemistry courses for both undergraduate and graduate students specializing in Environmental Chemistry at ESF. Despite its broad name, the "Methods" course only covers water analysis; there is no laboratory course here on the analysis of air.

Course Goals/Objectives

While we cannot hope to cover all the topics of significance to atmospheric chemistry or every atmospherically significant pollutant, you will be exposed to the most important issues in atmospheric chemistry. You will also be prepared to understand many topics omitted from the course as well as issues that may arise in the future.

In determining the significance of an a compound, a reaction, or an issue, one might need to know how much of the compound is present, the extent to which the reaction occurs, or the contribution of that reaction or compound to the overall problem. In other words, one needs information. Given our somewhat fragmentary knowledge of atmospheric abundances, reaction rate constants, and problems, there are few areas where we can say, "________ is always/never a concern." Therefore, the ability to remember or look up information or answers is NOT a sufficient skill.

I believe, instead, that a professional must be able to use data to calculate the best present estimate of the magnitude of the problem (or the magnitude under hypothetical conditions), and that is what I hope to teach you to do. We will make extensive use of kinetics to understand atmospheric issues. This is the training the will enable you to achieve the grandiose goal, stated two paragraphs above, of being "prepared to understand many topics omitted from the course as well as issues that may arise in the future."

Course Description and Organization

After a basic introduction to atmospheric issues, composition, and structure, we will focus on the stratosphere, that portion of the atmosphere between about 10 and 50 km. We will use the relatively simple chemistry of the stratosphere to introduce concepts of kinetics, photolysis, and catalytic cycles that are broadly important in atmospheric chemistry. We will then turn to the troposphere, the layer of the atmosphere extending from the ground up to the bottom of the stratosphere. The concepts listed above will then be applied to the messier chemistry of the lower atmosphere. The study of aerosols will emphasize thermodynamics as much as kinetics. Near the end we will cover global climate change.

Academic Dishonesty: A fancy word for Cheating

Full details appear in the Code of Student Conduct, to be found in your Student Handbook. The most relevant passages are excerpted here:

> Examples of academic dishonesty include, but are not limited to, actions defined below.
>
> .
>
> ..
>
> c) Writing, or attempting to write an examination paper, computer work, or other material for another student; allowing someone else to take one's examination.
>
> d) Possession of examinations or other test materials without permission of the instructor.
>
> e) Using …books; looking at another's paper; or talking to someone other than the instructor or proctor during an examination, without the instructor's permission.
>
> f) Failing to follow the rules of conduct for taking an examination as stipulated by the instructor prior to the examination or as stated by the instructor in a written course syllabus.

The penalties for cheating that will be administered by the instructor include a zero on the particular assignment and, possibly, <u>failing the course</u>. The incident will definitely be reported to the administration per ESF policies on Academic Integrity. Further details, including information about additional penalties that could be handed down by the administration, appear in the Academic Integrity Handbook.

My attitude towards cooperation on homework is described below in the section entitled "How to Get a Good Grade in this Course". Also, read point (f) above, substituting the work "homework" for "examination."

How to Get a Good Grade in This Course

My goal for you is not that you get a good grade in this course, although I would be delighted if you all earn high marks. Rather, <u>my goal is to have you learn the principles of atmospheric chemistry and how to apply them</u>. Why then, do you ask, do I give advice on getting a good grade? The answer is that the homework, projects, and exams will be structured so that it is very difficult to do well without understanding the material. I will attempt to set up this course so that studying for the exams is learning atmospheric chemistry rather than an exercise in memorization of facts, formulas, and algorithms for doing problems. Studying for mastery does not take much more time or effort (perhaps less) than memorization, and it leads to better grades, better long-term retention, and a greater ability to apply your knowledge to real problems.

"You damn sadist,' said mr cummings,
'you try to make people think.'
Ezra Pound, Canto 89, 1956

Despite this grand claim, I must acknowledge that you will need to learn facts to do well in the course. Atmospheric chemistry is not a unified body of knowledge, and without facts as a guide (O_2 constitutes 21% of the atmosphere by mole fraction) you can get far off track.

So how should you study?

<u>Come to class and participate</u>

I will be presenting material that is not in the text or in a different manner than the text, and integrating material from other texts, reviews, or papers. I will also try to organize the material and make it more coherent; it is often difficult for students to see the organization of material by reading a textbook. Also, the act of copying down formulas I put on the board or things I say in class is a first step towards learning the material. This is particularly true if you can edit what I say and write, either while taking notes or in while studying outside of class. If you can do this, you will have already begun grappling with the material. In the jargon of pedagogy this grappling is called *active learning*, the opposite of passive learning. Active learning is the way people actually master skills or academic subjects.

We will be discussing answers to homework *Problems* in class. Questions based on the same logic as the *Problems* will appear on the exams. We may use class time to address problems that are not part of the homework, but do address important concepts (i.e., ones worthy of a test question).

Much of the learning will take place in class discussing answers to the problems. Also, you may find yourself curious about issues other than those which are the focus of a lecture or homework. Your questions on those issues and the quality of your participation in class discussions can raise your class grade. Ask questions in class. If you have a question, it is likely that half the class is also wondering about the same topic. Even the best students in the class may learn something from the answer to the question you worry is too "dumb" to ask.

<u>The Textbook and Other Assigned Readings</u>

Do the assigned reading - before the topic is discussed in class. This will be necessary to do the Exercises and prepare for in-class assignments. It will also help you to get an idea of where I am going in lecture, which will help you take better notes and get more out of the lecture. When studying outside of class, try to see how presentations in the readings and in the lecture are linked.

<u>Homework</u>

I will assign some relatively straightforward problems (*Exercises*) for you to do. These will generally be tied to the assigned reading or lecture; my answers will be posted or put on reserve. You are responsible <u>outside of class</u> for making sure you understand the correct answers. *Exercises* are often the basis for *Problems* and for graded in-class assignments. Therefore, you need to make sure you understand the answers to the *Exercises*. *Exercises* will <u>not</u> be graded unless announced in advance, so you are generally allowed to give or accept help on the *Exercises* that would constitute cheating if done for graded assignments (like the *Problems*).

As mentioned above, I will also provide you with less straightforward questions, the *Problems*, which will be collected and graded. A person can't learn to drive a car just by reading the textbook in their Drivers Education class or watching someone else drive: one needs to actually get in the car and drive. By this analogy, the *Problems* for this class might be the practice drives you take in an empty parking lot before you first get on the road: you learn in a place where no one can get badly hurt (your performance on the *Problems* does not count towards a huge part of your grade). Doing problems and answering questions is the best, for some the only way, to begin to learn most technical subjects.

You are allowed, nay, encouraged, to cooperate a little bit on the homework. If you are stumped about how to approach a problem, don't stay that way. Ask for a hint ("What facts, relationships, or equations do I need in order to solve this problem? What error am I making in what I have done so far?"). Once you have an answer that seems right, it is appropriate to check with your classmates, and to think together about the way to understand or do a problem, or to point out and explain flaws of logic or math. Giving this type of assistance to a classmate benefits the giver, also, by forcing them to clarify their own thinking about the material. This cooperation is particularly appropriate to the *Problems* we will be discussing in class. However, it is <u>cheating</u> to accept help line by line or to copy or paraphrase someone else's answers.

The goal of the homework is for you to begin to learn the material. <u>If you cheat, you defeat the goal of doing the homework and lower your chances of getting a good grade</u>.

While we will discuss some of the homework problems in class, we will not have time to go over the *Exercises* or even all the *Problems*. Take the time to examine the things you did right and wrong on the homework. However, it is not sufficient to merely be able to do the problems. You need to think about the answers, whether they make sense chemically, physically, mathematically, and atmospherically, and why they are what they are. <u>On the examinations you will often be asked to explain things, instead of, or in addition to, providing numerical answers</u>.

If you can't do a homework problem, and ask me or a classmate for help, try to formulate a specific question. That way, you may get the clues that allow you to solve it yourself. The gain in your understanding and the satisfaction of figuring it out for yourself will help you much more than having someone else show you how to do the problem.

<u>Projects</u>

Projects are designed to help you understand topics where an extended computation is required (something too big for a homework problem. Projects count directly towards your grade, and questions relevant to the projects may appear on the exams!

<u>Office Hours and Help Sessions</u>

E-mail me or stop by my office when you have questions. Set up an appointment in advance if you have trouble finding me.

<u>Examinations</u>

All exams are planned as take-home exams: you will be able to use your textbook, your notes, my answers to homework, and some other resources to be specified later. Several days before an exam, review your notes and the textbook to identify ideas that are unclear; then clarify them. Try doing the homework assignments again (without looking at the answers). If you have questions, get them answered. Also, you can benefit by getting together with your fellow students to figure out the difficult points.

Many students get into trouble by not reading exam questions carefully. If you answer the wrong question without realizing it, you will get zero credit.

However, if you realize that you don't know how to answer the question, then you might try to provide some information about the answer. On quantitative questions a numerical estimate is best, but information along the lines of whether the answer will be larger or smaller than the initial value, positive rather than negative, a large number or a small number. Similarly, if you know an answer is wrong, but can't figure out how you got the wrong answer, you can help yourself by writing something like: "This answer is wrong because X; I don't know how I got it wrong." If you do this you might not lose as many points as you otherwise would for the error. The X in the above should be something like "the answer should have been larger than the initial value (positive, a large number) rather than smaller (negative, a small number)."

When you are Struggling

As noted in the ESF Student Handbook, there are offices at both ESF and SU available to **provide academic support, as well as career and personal counseling**. The ESF Office of Career and Counseling Services, 110 Bray Hall, 470-6660, can direct you to the proper source of help. **Confidentiality is assured**.

If you have **family or health emergencies** that will interfere with your ability to succeed in this or other courses, visit or call the Office of Career and Counseling Services. They can give official endorsement to your need for accommodation. This office will also contact all your class instructors for you, should such an emergency require you to be absent from campus.

Information Resources to be Found on the Course Web Page

1) Detailed Learning Goals
2) Additional Useful Readings
3) Links to Useful Web Sites
4) Links to My Spreadsheets for Calculating Termolecular Rate Constants, etc.