DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY
CHEMISTRY 3410, FALL 2017
ATMOSPHERIC CHEMISTRY

Instructor: Professor Brian J. Majestic
Office: Office SGM 151 / Lab 143
Office Phone: 303-871-2986
Cell Phone: 480-204-9515
Email: brian.majestic@du.edu
Office Hours: See lecture slides

Course Description: This is a course in atmospheric chemistry – an examination of the Earth's atmosphere as a chemical system with emphasis on how humans perturb this system through resource use, population impact, and introduction of pollutants. For some topics, technologies that create alterations, as well as those that attempt to alleviate human impact are also discussed.

It is assumed that you have a sound knowledge of general chemistry and basic organic chemistry. Having taken other, upper-division CHEM, PHYS, or beginning ENGR courses may be beneficial as well; however, concepts from other specialized sub-disciplines of Chemistry, Engineering, and Physics will be brought in and explained as appropriate.

Textbooks: We will be using the following textbook:

- Jacob DL *Introduction to Atmospheric Chemistry*, 1999, Princeton University Press, ISBN: 978-0-69-100185-2

The .pdf version of this textbook is available ***free*** online at

http://acmg.seas.harvard.edu/publications/jacobbook/index.html.

If you prefer a hardcopy, then you may purchase one from Amazon or similar. A recent check (April 2019) revealed used copies for as low as $40.

I will also be drawing off of the following textbooks, and would highly suggest purchasing (or checking out at the library) at least one of these (especially one of the first two) if you plan to make a career out of atmospheric chemistry or pollution control.

- Finlayson-Pitts BJ and Pitts JN; *Chemistry of the Upper and Lower Atmosphere*, 2000, Elsevier Inc, ISBN: 978-0-12-257060-5
- Seinfeld JH and Pandis SN; *Atmospheric Chemistry and Physics*, 2006, John Wiley & Sons, ISBN: 978-0-47-182857-0
- DeNevers N; *Air Pollution Control Engineering* 2nd Ed., 1999, McGraw Hill Inc., ISBN: 978-0-07-116207-4

Other Resources: In addition to the textbook and lecture presentations, you will have the opportunity (and expectation) to consult other resources. These will consist of websites (laboratories, trade associations, government sites, user groups, and list-servers), electronically available journals, and paper-based journals. Most journal articles published 1970-present are available in electronic format and may be printed and/or stored in journal publication format as

*.pdf format. Two examples of where to look are as follows: A) the ACS journals (pubs.acs.org) are available from any DU-based URL; and B) many other journals are available free of charge from several databases available at the DU Library website (www.library.du.edu/). The most useful databases are A) www.sciencedirect.com, "Sciencedirect", a service with > 1000 full-text journals which the DU library subscribes to, and B) the Web of Science, which can be accessed directly from the Penrose Library webpage (search the Databases at http://library.du.edu/site/). All of the library databases are available without a personal account from any campus-based URL; however, you can access them from off-campus through the DU library's website with proxy identification.

The University Libraries Research Center answers research questions seven days a week by phone, email, in-person, chat/IM or text. One-on-one research consultations in the Anderson Academic Commons are also available on a drop-in basis or by appointment. Consultations help students at any stage of the research process, from refining a topic, to finding books and articles, to creating a bibliography with RefWorks. Ask a question or make an appointment at 303-871-2905 or research-help@du.edu.

Course Topics

I. Structure of the Atmosphere and Basic Tools

- *Temperature and pressure gradients*
- *Scale heights*
- *Meteorology*
- *Equilibrium vs kinetics*
- *Mass Balances*

II. Local and Regional Issues – Gas Phase Chemistry

- *The chaotic nature of combustion: primary emissions of SO_2, NO_x, CO, VOCs*
- *Secondary pollutants - VOCs and the formation of ground-level ozone*
- *Fewer emissions: does this really solve the problem? The complex equilibrium between VOCs, NO_x, and ozone*

III. Particle phase chemistry

- *Sizes and physical properties of atmospheric aerosols*
- *Primary emission sources and characteristics*
- *Oxidation of VOCs by free radicals and secondary organic aerosol (SOA) formation*
- *Particle measurement techniques*

IV. Global Issues

- *Beer's Law photochemistry*
- *Stratospheric Ozone Chemistry*
- *Greenhouse Effect and Climate Change*
- *Dust in the Atmosphere*

V. Student Presentations (see details at the end of the syllabus). Ideas include…

- *Inhalation of atmospheric particulate matter and health effects*
- *Indoor air pollution*
- *Diesel exhaust emissions and the effect of selective catalytic reduction (SCR) technology*
- *Particulate pollution in **developing** Asian cities*
- *Instrumentation: measuring trace gases in the atmosphere*
- *Instrumentation: single – particle mass spectrometry* (continued on next page)

- *Atmospheric dust: transport and origin*
- *Biomass burning (natural: e.g. forest fires): local, regional, and global implications*

Note that this class is not a prerequisite for any further classes. Therefore, this schedule is ***extremely*** flexible. If you want to go deeper into a topic currently under discussion or if there is a general consensus that we should skip something so we can get into other topics, then say so!

Evaluation Methods

Over the 10 week quarter, you will be evaluated by several criteria. Specifically, you will be expected to complete the following:

- 1 mid-term exam, 5-6 weeks through the term.
- Regular "academic" homework assignments (close to every week, but not quite)
- 2 short, "applied" assignments
- 1 end-of-quarter presentation, including a 1 page written summary
- 1 Final Exam

In the event that you must miss the in-class exam, please let me know ASAP (in advance if possible) and a makeup will be scheduled. I am generally reasonable, but reserve the right to deny makeup exams for confabulated reasons, in which case your missed exam will be counted as a zero.

**** The final examination will be given in person on Tuesday, June 11, 2019 from 10:00pm to 11:50pm, as dictated by the DU final exam schedule.*** Rules regarding makeup of missed final exams and conflicts with excessive numbers of final exams will be dealt with as described by DU policy.

The breakdowns, immediately below, reflect the "default" grading distribution. As with everything in life, **this is negotiable.** If you believe that you would perform better with different weightings, then we can meet in-person to discuss this. If you do not meet with me before **Monday, September 18**, then you will be relegated to the default distribution.

* Summary of evaluation:

Midterm	= 20 %
Final exam	= 20 %
Final Project	= 20 %
Standard Assignments	= 20 %
Applied Assignments	= 10 %
Short literature presentation	= 10 %

A	$\geq$ 93 %	C	$\geq$ 69 %
A-	$\geq$ 90 %	C-	$\geq$ 65 %
B+	$\geq$ 87 %	D+	$\geq$ 62 %
B	$\geq$ 83 %	D	$\geq$ 58 %
B-	$\geq$ 80 %	D-	$\geq$ 54 %
C+	$\geq$ 74 %	F	$\leq$ 54 %

I reserve the right to make downward adjustments to this scale (i.e. adjustments in the direction of leniency). In no event will the actual scale used be adjusted upward from that described above.

Special Project:

In the last week of this course, you will lead a 25 min (20 min presentation + 5 min discussion) presentation. Given the time-constraints of a 50 min class, **it is important that you stick to these limits**. In addition, a **1 page maximum** (single-spaced, 12 pt Times New Roman or 11 pt Arial, title page and references excluded) Executive Summary of your findings will be turned in on the date of your presentation. You should work in groups of approx. 2-3, depending on how many people are in the course. The purpose of this project is for you to become an expert in one topic relating to air pollution. You will be expected/required to read and understand the current scientific literature relevant to your topic. Some useful journals include*: Environmental Science & Technology, Aerosol Science and Technology, Atmospheric Environment, Atmospheric Chemistry and Physics, Atmospheric Pollution Research,* etc.

Please be prepared to lead the class for your presentation – these topics **will** be covered at the Final Exam! Here are some tips for a successful discussion:

1. At least one week prior to your scheduled date, send me 1 literature paper related to your topic. I will distribute these out to the rest of the class so they will be prepared.
2. You are free to use slides, powerpoints, demonstrations, skits, or anything else which will help the class learn the material.
3. This is not a trivial task – I suggest that you start researching at the beginning of the quarter.
4. I am happy to meet with your group as much as you'd like for consultation. However, you are **required** to meet with me **twice** during the quarter.

Relevant Dates:
Wednesday, April 3: Turn in top 3 choices in-class (see V in "**Course Topics**")
Friday, April 5: I will assign groups based on preferences
Friday, April 26: Deadline for Meeting #1
Friday, May 17: Deadline for Meeting #2
June 4 and 6: Presentations

Presentation grade break-down:
One grade will be assigned to the group as a unit, with the exception of the peer and partner grade components (15% of presentation grade).

Preparation (*5 pts*)
- Meeting #1 (prior to October 7) (2.*5 pts*)
- Meeting #2 (prior to October 27) (2.*5 pts*)

Content (*30 pts*)
- Appropriate scope (*5 pts*)
- Background and motivation (*5 pts*)
- Relevant and correct chemistry/concepts (*10 pts*)
- Summary/Conclusions (*5 pts*)
- Answers to questions (*5 pts*)

Form and style (*30 pts*)
- Slide quality (uncluttered, clear) (*10 pts*)
- Clear explanations (5 pts)
- Verbal quality, eye-contact, body-language (*5 pts*)
- Team balance (*5 pts*)
- Timing (*5 pts*)

Executive Summary (*15 pts*)
Three multiple choice questions (with answers) for use on the Final Exam (5 pts)
Peer and partner grade (*15 pts*)