

## SYLLABUS

### **ENVR 675: Air Pollution Chemistry and Physics Fall 2017**

Class meets: Mondays & Wednesdays 2:30-3:45, McGavran-Greenberg 1302

Instructor: Jason West

Office: 146B Rosenau

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Office Hours: After class Mondays & Wednesdays, 3:45-4:30

#### **Course Description and Goals**

Air pollution has significant effects on human health and the environment, through interrelated problems of ozone and particulate matter air pollution, acid rain, visibility degradation, mercury, stratospheric ozone depletion, and climate change. Significant strides have been made in the past few decades to improve our understanding of the sources, chemical transformation, transport, deposition, and impacts of different pollutants. We now understand that many air pollutants are linked together through complex chemical interdependencies.

This course is designed for first year graduate students planning to do research on the fate and transport of air pollutants, intending to cover the basics that all such students should know – whether they are experimentalists or modelers, and regardless of their educational background. Other students can also benefit from this course, including students researching air pollution health effects and environmental modeling.

Students will be expected to show mastery of relevant concepts drawn mainly from the Earth sciences, chemistry, physics, and engineering. By the end of this course, students will be able to:

- Explain current air pollution research in the context of the history of air pollution science.
- Explain the relationships between emissions of different air pollutants from different sources, their atmospheric concentrations, and the impacts that they ultimately cause.
- Explain the factors that influence the transport of pollutants around the world.
- Explain the chemical processes that govern the formation and destruction or removal of air pollutants, principally ozone and particulate matter.
- Understand basic laboratory and field techniques in the measurement of air pollutants.
- Participate in smog chamber analyses of chemical transformations of pollutants.
- Apply quantitative analyses related to air pollution through homework problems and on tests.
- Read and understand recent scientific findings from journal articles.

In completing this course, students will improve their fundamental knowledge of air pollution, and will also learn skills in analyzing chemical processes, quantitative scientific methods, and modeling.

## Prerequisites

This is a graduate level course. Advanced undergraduates will be admitted to the course with permission of the instructor. Students must have:

- had at least one undergraduate course in chemistry.
- had at least one undergraduate course in physics.
- comfort with math.

## Course Requirements and Evaluation

Class participation	10%
Homework assignments	40%
In-class quizzes	12%
In-class exam	13%
Final exam	25%
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	100%

Homeworks are expected to be turned in on time. Late homeworks will lose 10% for each day late, except for exceptional circumstances and the prior approval of the instructor. You are encouraged to work in groups for your homeworks. However, each student is responsible for writing up and turning in their own results for their homework. If you work with others, you are required to include a note on your homework with the names of the people you work with (working with others does not count against you, but you will lose a point if you fail to acknowledge them). Handing in homework identical to another student's is not acceptable.

## Feedback on the Course

You are expected to complete the online evaluation forms for this course (and for all your courses) during the last two weeks of the semester. I also welcome your feedback at any time while the course is in progress. Please arrange to meet with me and discuss, or you may also leave comments anonymously by putting a note in my mailbox.

## Readings

There is one required text:

Daniel J. Jacob, Introduction to Atmospheric Chemistry, 1999, Princeton University Press.

This book is available for free on the web:

<http://acmg.seas.harvard.edu/people/faculty/djj/book/index.html>.

We will also read from the NARSTO PM Assessment (2004), which is available online for free:

[http://www.narsto.org/pm\\_science\\_assessment](http://www.narsto.org/pm_science_assessment).

In addition, research articles will be handed out in class. Other books are not required to purchase, but are recommended for students planning to focus their research on air pollution:

John H. Seinfeld and Spyros N. Pandis, Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, 2<sup>nd</sup> Edition, 2006, Wiley.

Barbara J. Finlayson-Pitts and James N. Pitts, Jr., Chemistry of the Upper and Lower Atmosphere, 1999, Academic Press.

Mark Z. Jacobson, Atmospheric Pollution: History, Science, and Regulation, 2002, Cambridge Univ. Press

Mark Z. Jacobson, Fundamentals of Atmospheric Modeling, 2<sup>nd</sup> Edition, 2005, Cambridge Univ. Press.

### **Course Schedule (subject to updates)**

Wed., Aug. 23 Introduction to class, Historical view of air pollution problems

Mon., Aug. 28 Atmospheric structure and composition, pressure, Ideal Gas Law, units of atmospheric composition

Wed., Aug. 30 Atmospheric trace constituents: sulfur-containing, nitrogen-containing, and halogen-containing compounds, ozone

Mon., Sept. 4 NO CLASS - Labor Day

Wed., Sept. 6 Atmospheric trace constituents: carbon-containing compounds, water vapor.

Fri. Sept. 8 SPECIAL CLASS Simple models, atmospheric lifetime.

Mon., Sept. 11 Transport of pollutants, global meteorology

Wed., Sept. 13 Meteorology: Atmospheric stability

Fri., Sept. 15 SPECIAL CLASS Chemical kinetics, atmospheric radiation and photochemistry

Mon., Sept. 18 QUIZ 1

Wed., Sept. 20 Stratospheric ozone chemistry and the Ozone Hole

Mon., Sept. 25 Stratospheric ozone chemistry and the Ozone Hole

Wed., Sept. 27 NO CLASS

Mon., Oct. 2 Tropospheric ozone chemistry

Wed., Oct. 4 Tropospheric ozone chemistry, NO<sub>x</sub> and Radical cycles

Mon., Oct. 9 Tropospheric ozone chemistry, role of CO and VOCs

Wed., Oct. 11 Tropospheric ozone, reactions of individual VOCs

Mon., Oct. 16 Urban ozone sensitivity and isopleths. Global ozone.

Wed. Oct. 18 EXAM

(Fall Break, Oct. 19-22)

Mon., Oct. 23 NO CLASS - CMAS Conference

Wed., Oct. 25 NO CLASS - CMAS Conference

Mon., Oct. 30 The continuity equation and atmospheric modeling, Use of a chemical solver

Wed., Nov. 1 Overview of Particulate Matter

Mon., Nov. 6 Overview of PM

Wed., Nov. 8 QUIZ 2

Mon., Nov. 13 Air pollution measurements (Glenn Morrison)

Wed., Nov. 15 Air pollution measurements (Glenn Morrison)

Mon., Nov. 20 Inorganic PM

Wed., Nov. 22 NO CLASS – Thanksgiving

Mon., Nov. 27 Inorganic PM, acid rain

Wed., Nov. 29 Air pollution health effects (Ilona Jaspers)

Mon., Dec. 4 Visibility, Air pollution health effects

Wed., Dec. 6 Air pollution regulation

**Fri., Dec. 8 4-7 PM Final Exam**