EHS 225: COURSE SYLLABUS

ATMOSPHERIC TRANSPORT AND TRANSFORMATIONS OF AIRBORNE CHEMICALS

Tuesday and Thursday: 10:00-11:50 am, CHS 61-269, Winter 2018

Instructor

Yifang Zhu, Ph.D.
Professor
E-mail: yifang@ucla.edu

Special Reader

Yan Lin, 51-295 CHS
E-mail: linyan1002@gmail.com

Course Prerequisites

The course prerequisites are undergraduate physics (e.g., thermodynamics, fluid mechanics, and heat and mass transfer), calculus (including differential equations), probability and statistics, and organic and physical chemistry (including kinetic theory). You are responsible for supplemental work that you may need to catch up in any of the prerequisite areas.

Text Book

ATMOSPHERIC CHEMISTRY AND PHYSICS: FROM AIR POLLUTION TO CLIMATE CHANGE, John H. Seinfeld and Spyros N. Pandis, Second Edition, 2006. (SP)

Reference Books

CHEMISTRY OF THE UPPER AND LOWER ATMOSPHERE, Barbara Finlayson-Pitts and James N. Pitts, Jr. First Edition, 2000. (FP)

INTRODUCTION TO ATMOSPHERIC CHEMISTRY, Daniel J. Jacob, Princeton University Press, 1999. (http://www-as.harvard.edu/people/faculty/djj/book/) (J)

Other Required Readings:

Lecture slides and journal articles will be posted on the course website.

Week	Topic
1	**Introduction**: Course Structure and Overview; EPA STAR Proposal Project; Literature Search using Library Database; The Air Pollution System; Atmospheric Composition; Properties of Air; Concentrations of Gaseous Species: Concentration Units and Unit Conversion; Human Impact on Air Pollution at Global and Urban Scales; Historical Perspective; "Health" Implications; The Major Air Pollution Problems; Criteria Air Pollutants and Ambient Air Quality Standards; Classification of Air Pollutants. **Reading:** SP Chapter 1 & 2; FP Chapter 1 & 2.
1	**Emission Inventory**. Emission Sources by Origins; Point Sources; Area Sources; Mobile Sources; Types of Emission Inventories; Bottom-Up vs. Top-Down Approach; Estimation Methods (Source testing, Emission factor, Mass balance, Emission estimation models, Surveys and questionnaire, Engineering judgment/best approximation); Available Emission Databases and Related Data Sources. **Reading:** SP Chapter 1 & 2; FP Chapter 1 & 2.
2	**The Structure of the Atmosphere and Air Pollutant Transport**: Vertical Temperature Profiles; General Circulation of the Atmosphere; Coriolis Effect; Hemispheric and Global Mixing; Scale of transport; Sulfur, nitrogen, and carbon cycle. **Reading:** SP Chapter 21&22; J Chapter 1 & 2.
2	**Atmospheric Stability**— Lapse Rates; Temperature Inversion; Surface Inversion; Inversion Aloft; Vertical Expansion of Plumes; Typical Time Scales for Vertical Mixing. **Reading:** SP Chapter 16; J Chapter 3 & 4.
3	**Atmospheric Modeling (I)**—One-Box Model; Special Case Box Model; Two-Box Model; Column Model; Atmosphere Residence Time; Dry Deposition of Gases and Particles; Wet Deposition **Reading:** SP Chapter 18; J Chapter 3 & 4.
3	**Atmospheric Modeling (II)**— Gaussian Plume Model; Special Case Gaussian Plume Model; Dispersion Coefficients; Plume Rise. Eulerian and Lagrangian Models; CALINE4; CAL-Puff; Dr. Matthew O'Donnell Guest lecture on 1/25 (Thursday) **Reading:** SP Chapter 18; J Chapter 3 & 4.
4	**Chemical Kinetics**— Order of Reaction; Theories of Chemical Kinetics; Reaction Orders; Derivation of Atmospheric Lifetimes; Carbon Dioxide Lifetime. **Reading:** SP Chapter 3; FP Chapter 5; J Chapter 9.
4	**Troposphere Chemistry (I)**— OH Radicals; Photochemical Cycle of NO2, NO, and O3; Ozone Budget of the Troposphere and Role of NOx. **Reading:** SP Chapter 4&6; FP Chapter 14; J Chapter 11&12.
5	**Troposphere Chemistry (II)**— NOx and NOy Family; Ozone Air Pollution; Relative Roles of VOC and NOx in Ozone Formation. **Reading:** SP Chapter 4&6; FP Chapter 14; J Chapter 11&12.

5 **Mid-Term Exam**

6 **Stratosphere Chemistry**—Overview; Chapman Mechanism; Nitrogen Oxide Cycles; Ozone Hole; Ozone Depletion Potential. **Reading:** SP Chapter 5; FP Chapter 12; J Chapter 10.

6 **Atmospheric Aerosol** — Particle Size Distributions and Chemical Composition; Particle Residence Times; Gas-to-Particle Conversion; Role of Proximity to Sources; Impacts on Visibility and Human Health. **Reading:** SP Chapter 8; FP Chapter 9; J Chapter 8.

7 **Dynamics of Single Aerosol Particles** — Equivalent Particle Diameter; Stokes' Law; Gravitational Settling; Stop Distance and Stokes Number; Brownian motion. **Reading:** SP Chapter 9.

7 **The Air Quality Policy and Emission Control in California**; Dr. Tao Huai's guest lecture on 2/22.

8 **Air Pollution Environmental and Health Impact** — Environment; Ecological System; Air Pollution Health Effects in the Long-Term; Short-Term; Pulmonary; Near-roadway; Cardiovascular; Birth Effects; Epidemiological Evidence; Toxicological Evidence. **Reading:** Journal Articles.

8 **Particulate Matter Health Effects** — Long-Term; Short-Term; Pulmonary; Cardiovascular; Birth Effects; Epidemiological Evidence; Toxicological Evidence. **Reading:** Journal Articles.

9 **Indoor Air Pollutants** — Sick Building Syndrome; Importance of Human Time- Activity Patterns; Microenvironment; Emissions from Combustion Sources; Tobacco Smoke; Building Materials; Asbestos; Radon; Consumer Products; Penetration of Outdoor Air; In-Cabin Environment. **Reading:** FP Chapter 15, Journal Articles.

9 **The Greenhouse Effect and Global Climate Change**; Planetary Temperatures; Infrared Window; Accumulation of Greenhouse Gases; Trends in Atmospheric Concentrations; Radiative Forcing; Relative Contribution of GHGs: Carbon Dioxide; Methane; Nitrous Oxide; Chlorofluorocarbons (CFCs); HCFCs; HFCs; Halocarbon Global Warming Potential; Feedback Mechanisms; Evidence of Warming. **Reading:** SP Chapter 23, FP Chapter14, ICPP 5th Report.

10 **Field trip to SCAQMD/El Monte ARB laboratory, buffer lecture, and course review.**

10 **EPA STAR proposal class presentations. Course Review and Open Discussion**

Final Exam: Tuesday, March 20, 2018, 3:00 PM - 6:00 PM

Learning Objectives and Competencies

Upon completion of this course, you should be able to demonstrate the skills listed as "Course Learning Objectives" below. These learning objectives were selected to help you build skills related to help undergraduates build competencies outlined in the ASPH Undergraduate Public Health learning Outcomes Model (http://www.asph.org/document.cfm?page=1085) and to help MPH, MS, and PhD students in Environmental Health Sciences .

COURSE LEARNING OBJECTIVES	*HOW THESE LEARNING OBJECTIVES ALIGN WITH COMPETENCIES FOR SPECIFIC DEGREE PROGRAMS*			
	Undergraduate Public Health Learning Outcomes	*ASPH MPH Competencies*	*EHS MS Competencies*	*EHS PhD Competencies*
1. Accurately and effectively communicate environmental health risks to critical stakeholders individually and as part of a team.	2.4 Communicate health information to a wide range of audiences through an array of media.	F. 7. Demonstrate effective written and oral skills for communicating with different audiences in the context of professional public health activities. H.4. Engage in dialogue and learning from others to advance public health goals. H. 7. Use collaborative methods for achieving organizational and community health goals. H. 9. Develop strategies to motivate others for collaborative problem solving, decision-making, and evaluation.	E. 2. Deliver effective oral presentations individually and as part of a team E. 3. Explain and interpret research findings for students, professionals, the public, and media E. 4. Work effectively as part of an interdisciplinary team	E. 1. Gauge the cultural background, knowledge base and skills of an audience to appropriately customize communications for the target audience E.2. Organize and make oral presentations to professionals ranging from brief scientific presentations of research findings to longer presentations E.5. Demonstrate leadership in interdisciplinary teams, including project management, negotiation and conflict resolution
2. Tailor written communications so that they are appropriate to the target audience.	2.4 Communicate health information to a wide range of audiences through an array of media.	F. 7. (see above)	E. 3. (see above)	E. 1. (see above)

COURSE LEARNING OBJECTIVES	*HOW THESE LEARNING OBJECTIVES ALIGN WITH COMPETENCIES FOR SPECIFIC DEGREE PROGRAMS*			
	Undergraduate Public Health Learning Outcomes	***ASPH MPH Competencies***	***EHS MS Competencies***	***EHS PhD Competencies***
3. Describe the basic principles and complexity of air pollution research.		B. 1. Describe the direct and indirect human, ecological and safety effects of major environmental and occupational agents. B. 2. Describe genetic, physiologic and psychosocial factors that affect susceptibility to adverse health outcomes following exposure to environmental hazards. B. 3. Describe federal and state regulatory programs, guidelines and authorities that control environmental health issues. B. 4. Specify current environmental risk assessment methods. B. 5. Specify approaches for assessing, preventing and controlling environmental hazards that pose risks to human health and safety.	A. 1. Retrieve and organize literature; synthesize and critically evaluate scientific literature in Environmental Health, Public Health and other relevant fields A. 3. Evaluate seminars and presentations in Environmental Health and distill the critical and salient issues from them D.1. Make reasonable inferences from results of analysis of observational and analytic studies	A. 1. Judge, critique and interpret reports of individual Environmental Health studies; evaluate strengths and limitations of Environmental Health reports
4. To describe the most recent (state-of-the-art) knowledge in air pollution and the current topics and trends in air quality research.	2.3 Discuss the interconnectedness among the physical, social, and environmental aspects of community health.	B. 1. , B.2., B.3., B.4., and B.5 (see above)	A. 1. , A.3. and D.1. (see above)	A. 1. (see above)

COURSE LEARNING OBJECTIVES	*HOW THESE LEARNING OBJECTIVES ALIGN WITH COMPETENCIES FOR SPECIFIC DEGREE PROGRAMS*			
	Undergraduate Public Health Learning Outcomes	***ASPH MPH Competencies***	***EHS MS Competencies***	***EHS PhD Competencies***
5. Describe an example of air pollution and related health effects and how a prevention approach could be used to address this problem.	3.5 Champion the role of prevention in promoting a healthy community.		A. 1. , A.3. and D.1. (see above)	A. 1. (see above)
7. Gain hand-on experience on air pollution research.		B. 1. , B.2., B.3., B.4., and B.5 (see above)	A. 1. , A.3. and D.1. (see above)	A. 1. (see above) B.1. Formulate a research question and determine the appropriate study aims, objectives, study design and hypothesis to address the research question.
8. Describe an example of how regulations and/or inspections have been used to prevent air pollution; describe who has the authority to impose these regulations in our region.			A. 1. , A.3. and D.1. (see above)	A. 1. (see above)