CH EN 5305/6305 – Air Pollution Control Engineering

Department of Chemical Engineering
University of Utah
Last Revised 2022 January 5

Semester	Spring 2022
Instructor	Geoff Silcox (geoff.silcox@utah.edu) Room MEB 3290 C (801)581-8820 (office)
Meetings, assignments, quizzes, lecture notes, online discussion	Lecture: Tuesday, Thursday 10:45AM-12:05PM in WEB L122. Assignments, lecture note, and grades will be posted in Canvas. Homework will be submitted in Canvas. We will be using Ed Discussion for asking questions about the homework. Rather than emailing questions to Ayodeji or me, we encourage you to post your questions on Ed. There is a link to Ed in the left margin of Canvas.
Office hours	Stop by at your convenience or make an appointment
Website:	Canvas
Teaching assistant	Ayodeji Oluwaseun Ajani: u1269949@utah.edu Office hours: Thursdays, 3-5pm, Dougall Student Computing Lab, MEB 2285
Prerequisites	MATH 2250, PHYS 2220, CH EN 2300, CH EN 2450, CH EN 2800 and major status in Chemical Engineering
Recommended text	*Air Pollution Control Engineering*, Noel de Nevers, 3rd edition, Waveland Press, Inc., 2017. ISBN: 978-1-4786-2905-4.
Suggested references	*Fundamentals of Air Pollution Engineering*, Richard C. Flagan and John H. Seinfeld, Prentice Hall, 1988. Available online at http://resolver.caltech.edu/CaltechBOOK:1988.001. *Introduction to Environmental Engineering and Science*, Gilbert M. Masters, 3rd ed., Prentice Hall, 2008.
Course description	Air-pollution emission sources, behavior of pollutants in the atmosphere, theory, and practice of control of particulate and gaseous air pollutants at their sources.

Learning objectives By the end of this course you will be able to

1. Describe the effects of air pollutants on health, property, and visibility.
2. Make calculations of pollutant concentrations or emission rates for comparison with the standards of the Clean Air Act.
3. Use material, energy, entropy, and momentum balances in air pollution measurement and control calculations.
4. Critically analyze emission and ambient sampling techniques including placement of monitors and isokinetic conditions in probes.
5. Use basic meteorology to predict the distribution and fate of air pollutants in the atmosphere.
6. Calculate the concentration and dispersion of air pollutants using box and Gaussian plume models.
7. Apply general ideas in air pollution control that allow you to design equipment, calculate efficiency, calculate penetration, perform material balances for complex reacting systems including combustion reactions, and estimate acid dew points.
8. Make calculations relating to the nature of particulate including settling velocity, drag force, particle size distribution, source, and fate in the atmosphere.
9. Estimate the fate of primary particulate in wall and dividing collection devices.
10. Choose a particle collector for a particular application.
11. Evaluate different options for control of volatile organic compounds, sulfur oxides, and nitrogen oxides.
12. Make recommendations to address the motor vehicle problem.
13. Summarize engineering solutions to problems associated with air toxics, indoor air pollution, and radon.

14. Graduate students: create and deliver an interesting, content-rich presentation that is related to air pollution control or characterization.

Special dates

First day of class: Tuesday, 11 January
Last day to add or drop: Friday, 21 January
Last day to withdraw: Friday, 4 March
Classes end: Tuesday, 26 April
Reading Day: Wednesday, 27 April
Final Exam: Monday, 2 May, 10:30 am – 12:30 pm

Grading

UG: 20% homework, 80% exams.
Grad: 20% homework, 80% exams plus presentation to be weighted 20%.

Final grades will be based on the following table. The table represents grade guarantees. The high score in the class will be used to scale all other scores. For example, if the high score is 95%, all scores will be divided by 0.95. I reserve the right to reevaluate the grades of students who show exceptional performance on the final. I may lower the grading scale and may choose a lower scaling factor than that based on the high score.

Percentage	Grade
92-100	A
89-92	A-
85-89	B+
80-85	B
75-80	B-
70-75	C+
65-70	C
60-65	C-
50-60	D
< 50	E

Homework

Homework is due on Sundays by 11:59 pm and can be submitted in Canvas as a scanned pdf file or a Jupyter Notebook. Excel files may also be submitted. The solutions will be posted in Canvas. Late homework will not be accepted after the solutions have been posted. The neatness, organization, and completeness of your homework solutions will be evaluated in grading.

To receive full credit for your written solutions, you must write out all equations that you use, and you must state all values substituted in those equations. You must show all your work to receive credit.

I encourage you to work with other students on the homework. You are required, however, to turn in individual, original solutions for grading. You should be able to solve all problems on your own. Copying the assignments of others will constitute plagiarism.

Exams

The three exams will each have two parts: a closed-book, closed-homework, closed-note paper section; and an open-book, open-notes, and open-computer section.

Exam 1 is 40 minutes paper, 35 minutes computer.
Exam 2 is 40 minutes paper, 35 minutes computer.
Exam 3 is 80 minutes paper, 35 minutes computer.

Exam 3 is during finals week from 10:30 am 12:30 pm on Monday, May 2, in our regular classroom.

On exams, you must show all your work to receive credit for a solution. That is, you must write out the equations in symbolic form and provide all numerical values that you use.

Students with Disabilities

The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability and Access, 162 Olpin Union Building, 801-581-5020. CDA will work with you and Prof. Silcox to make arrangements for accommodations.

All written information in this course can be made available in alternative format with prior notification to the Center for Disability Services.

Addressing Sexual Misconduct

Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a Civil Rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066, https://deanofstudents.utah.edu/index.php. For support and confidential consultation, contact the Center for Student Wellness,

	426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS).
Counseling Center	The Counseling Center (http://counselingcenter.utah.edu/) is in Rm 426 of the Student Service Building. They are open Monday-Friday 8 am – 5 pm and can be reached at 801.581.6826. For after-hours emergencies, call 801.587.3000.
Campus Safety	To report suspicious activity or to request a courtesy escort, call campus police at 801.585.COPS (801.585.2677). If you choose, you will receive emergency alerts and safety messages via text messaging and email. For more information, see safeu.utah.edu.
Graduate students	Graduate students will be graded separately from undergraduates and may be called upon to address questions that the undergraduate section, 5305, is unable to answer. Graduate students will be required to present a 20-minute lecture to the class on a subject that is related to air pollution control or characterization.

Draft Schedule and Outline

Week	**Tuesday**	**Thursday**	**Deadlines**	**Reading**
Jan 11, 13	L01. Material balances and box models. IPAT eq., disaggregated growth rates.	L02. Concentration units. Effects of air pollution.	HW 1 due Jan 16 by 11:59pm	Ch 1, 2. Section 15.4.
Jan 18, 20	L03. Air pollution control and energy balances. Statistics and air pollution. Air pollution control laws.	L04. Air pollution measurements. Emission factors	HW 2 due Jan 23 by 11:59 pm	Ch 3, 4. Problem 4.20.
Jan 25, 27	L05. Meteorology. L06, Pollutant Conc. Box Models	L07. Gaussian plume models: temperature inversions and line-source models.	HW 3 due Jan 30 by 11:59 pm	Ch 5, 6

Feb 1, 3	L07. Gaussian plume models continued.	L08. General ideas in air pollution control. Efficiency, penetration, nines.	HW 4 due Feb 6 by 11:59 pm	Ch 6, 7
Feb 8, 10	L09. Combustion, acid dew point.	L10. Particle settling velocity using Stokes law.	HW 5 due Feb 13 by 11:59 pm.	Ch 7, 8
Feb 15, 17	Review	Exam 1		
Feb 22 , 24	L11. Particle size distributions	L12. Control of primary particulates. Gravity settlers. Cyclone separators.	HW 6 due Feb 27 by 11:59 pm. Lecture abstract due Feb 27.	Ch 8, 9
Mar 1, 3	L13. Cyclones. Spreadsheet for cyclone Example 9.6. ESPs.	L14. Fabric filters. Depth filters.	HW 7 due Mar 6 by 11:59 pm.	Ch 9
Mar 15, 17	L15. Scrubbers for particle capture. Scavenging of particles by rain.	L16. VOCs and tank losses. Adsorption and absorption for control of VOCs.	HW 8 due Mar 20 by 11:59 pm.	Ch 9, 10
Mar 22, 24	L17. Absorption, cont. Control of VOCs by combustion.	L18. Control of sulfur oxides	HW 9 due Mar 27 by 11:59 pm. Lecture outline due Mar 27.	Ch 10, 11
Mar 29, 31	L19. Control of nitrogen oxides.	L20. More on NO_x. Motor vehicles.	HW10 due Apr 3 by 11:59 pm.	Ch 12, 13
Apr 5. 7	Review	Exam 2		
Apr 12, 14	L21. Air pollution and global climate: models of earth and earth surface temperature.	L22. CO, lead, air toxics. Indoor air pollution.	HW 11 due Apr 17 by 11:59 pm.	Ch 14, 15

	Effect of solar variability.			
Apr 19, 21	L23. Atmospheric chemistry.	Graduate Student Presentations	HW 12 due Apr 24 by 11:59 pm. Presentation due Apr 24.	Ch 15, Appendix D
Apr 26	Review			

Final Exam on Monday, May 2, 10:30 am -12:30 pm.