Advanced Air Pollution Control Design

ENV 6126 Section 8083
Class Periods: M & W | Periods 6-7, 12:50PM – 2:45PM
Location: NEB 101
Academic Term: Fall 2018

Instructor:
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(352) 392-0845
Office Hours: Mon 3 – 4 PM, Tue 1-2 PM, or by appointment, 406 Black Hall

Teaching Assistants:
Please contact through the Canvas website
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Course Description
Principles of particulate and gaseous emission control; design and operation of particulate and gas control equipment for stationary and mobile sources to meet federal emission standards.
3 credit hours

Course Pre-Requisites / Co-Requisites
5105 Foundations of Air Pollution

By the end of the course, the student will be able to do the following:
1. To *explain* and *calculate* the statistics of a given **aerosol size distribution** and properties of gas (pressure, solubility and ideal gas law).
2. To *determine* the movement of aerosols by a given **transport mechanism** (inertial movement, diffusion and electrical migration) and *decide* the dominant collection mechanisms in a given aerosol system
3. To *determine* the major collection mechanism for a given gas compound (absorption, adsorption, chemical reaction, combustion, catalytic reaction)
4. To *explain* the **strategies** for NOx, SO_2 and CO_2 removal and the **mechanisms** employed
5. To *calculate* the **collection efficiency** of a given pollution control system and *evaluate* various parameters that affect the collection efficiency and cost
6. To *select* and *design* the **most appropriate** air pollution control system for a given particulate or gaseous emission scenario
7. To *explain* and *compare* different methods for controlling emissions from **mobile sources**
8. To *explain* air pollution control techniques to the **professional society** and **general public**

Materials and Supply Fees
Textbook cost: rent $51.58, buy used $96.75, or buy new $128.95 at UF bookstore

Required Textbooks and Software
- Air Pollution Control: A Design Approach
- C. David Cooper and F. C. Alley
- 4th Edition, 2011
- ISBN 1-57766-678-X.

Course notes are developed by the instructor and TA.

Course Schedule

Week 1:	Introduction / Dr. Wu / Cooper Ch 1 / Quiz 1
Week 2:	Gas Properties and Particle Characterization / Dr. Wu / Cooper Chs 1,3 / Quiz 2,3
Week 3:	Particle Motion / Dr. Wu / Cooper Ch. 3 / Quiz 4
Week 4:	Cyclones/ Dy. Wu / Cooper Ch 4 / Quiz 5
Week 5:	Mid-term 1 review / Anshassi / Exam 1
Week 6:	ESP's and Fabric Filters / Dr. Wu / Cooper Chapter 5,6 / Quiz 6,7
Week 7:	Particulate Scrubbers and Adsorption / Dr. Wu / Cooper Ch 7,12 / Quiz 8,9
Week 8:	Absorption / Dr. Wu / Cooper Ch 13/ Quiz 10
Week 9:	Mid-term 2 Review / Anshassi / Exam 2
Week 10:	Incineration, NOx, SO_2 / Dr. Wu / Cooper Ch 11,15,16 / Quiz 11,12,13
Week 11:	CO_2 and Mobile Sources / Dr. Wu / Cooper Ch 18,22 / Quiz 14,15
Week 12:	Emerging Air Pollution Control Technology / Dr. Wu / Quiz 16
Week 13:	Mid-term 3 review / Anshassi / Exam 3
Week 14:	No Class, Thanksgiving
Week 15:	Project Presentations / Student groups / Quiz 17
Week 16:	Project Presentations / Student groups / Quiz 18

Attendance Policy, Class Expectations, and Make-Up Policy

This is a flipped class. You need to watch the lecture video before coming to class for the specific topic. There is no lecture during the class time; instead, we'll conduct engineering design exercises and discussion activities. Questions and step-by-step instructions will be provided, and you are expected to be able to solve the problem by following the instruction. A submitted solution sheet gets checked for the given credit counted toward the grade. You are allowed to submit the solution sheet up to 2 days after the date of in-class design of that question.

Attendance is required and monitored based on **in-class group activity completion**, which provides the opportunity for bonus credit (per group member who actually participates; i.e. if absent, students will not have the opportunity to make up that day's bonus credit). Excused absences are consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation. There is **NO LIMIT** of the bonus points that a group is allowed to get.

General Assignment Policy

Assignments (revised homework and project proposal/reports) should be submitted **at the beginning of class time on specified dates**. 10% will be deducted for any late assignment (homework, project report) submitted on the same day after class, 20% for that submitted on the 2nd day, and 40% for that on the 3rd day. Any assignment submitted late for more than 3 days will **NOT** be accepted unless with a certified medical excuse or if it is agreed by Dr. Wu prior to the due time with reasonable explanation.

Students should form a team consisting of 3-4 people. A team needs to have at least one member from each gender (i.e. can not all be of the same gender). For the homework, each team only needs to submit **1** team copy. Select an **air pollutant** as your **team's name**. The names of all members of each team should be reported to Dr. Wu by **deadline on Schedule**. Those who do not belong to any team by the due date will be assigned by Dr. Wu and will forfeit their right to object the assignment. Each team should elect a **TEAM LEADER**. The team leader will be responsible for getting the assignments due on time and is compensated for an additional **5%** of the project grade. Each member's performance and contribution will be evaluated by team members in the middle and the end of the semester. If a member is determined by the team for not contributing his/her share, Dr. Wu may request the member to submit his/her assignment **individually**.

Quiz Policy: There will be two types of quizzes for each class, a short pre-class quiz and a longer post-class quiz. You should be able to answer the questions without complicated calculations. You need to review the videos before every class and finish a 10-min pre-class quiz by noon on the day of class (see class schedule). Only content from the video will be tested. **NO make-up** pre-class quiz will be allowed. However, every student is allowed to drop two pre-class quizzes (for any reason including sickness, family reunion, just feeling lazy or others) with the lowest grades when calculating the final grade.

Following each class there will be a longer 20-minute post-class quiz with more advanced questions. Contents covered in **class discussion** as well as **textbook**, in addition to the video lectures, will be included. The quizzes will be made available on e-learning (CANVAS) after each class and due after 1 week. **NO make-up** post-class quiz will be allowed since you will be able to drop 2 of these quizzes for any reason.

Homework Policy: For each homework assignment, **there will be 2 versions submitted**. Homework questions are posted on CANVAS at 1 week before the first deadline unless otherwise specified. The first version of the homework is to be completed and turned in to the best of your ability. After the first deadline, the solutions to the homework will be posted. Each student is then **responsible for grading their own assignment** and making all corrections that are necessary. Then the graded and corrected version of the homework will be submitted by the **second deadline 7 days later**, which will be graded by the TA. Both versions have the same weighting of the grade. Discussion among students is encouraged, but copying from other student's work is unacceptable (e.g. same mistakes) and both students will be reported to the University.

If your procedure is correct but there are errors in calculation, you get partial credit. It's important to **SHOW YOUR PROCEDURE CLEARLY**. You won't get any credit if your procedure is wrong or unclear, even if the numbers are mysteriously correct. If you use any number from any table or graph, you need to CITE the source (e.g. Table 1.1). There will be no credit for magic numbers that appear in the solution.

For questions that involve calculation, the following steps should be followed:

i. List all given conditions and parameters, e.g. T = 298 K, P = 1 atm, R = 8.314 J/mole·K and their sources, e.g. Textbook Appendix B; Fig. 14-1 in textbook.
ii. For each calculation step, the equation used for calculation should be listed, followed by the specific numbers replacing the parameters. Units should also be included in the calculation.
iii. The most important thing for the homework is to show the flow of your thought in solving the problem. Both hand-writing and typing are acceptable, but they need to be clear, neat and organized.

An example of homework preparation is given below. Be sure to follow the format before you submit your homework. It also helps you to get more scores in your exams.

Q1 The secondary NAAQS for SO_2 is 0.5 ppm (for a 3-hr avg). Calculate the equivalent conc. in μg/m^3 at standard temperature and pressure (STP: T = 25 ^oC, P = 1 atm)

Given:

C_{ppm} = 0.5 ppm

Solution:

Since it is at STP, use Equation 1.9

MW_p = 64 g/gmol

$C_{mass} = 1000 \times C_{ppm} \times MW_p / 24.45$ L/gmol = 1000×0.5 ppm×64 g/gmol/24.45 L/gmol

= **1309 μg/m^3**

- Graduate students may be assigned extra readings and questions of advanced topics.
- Each graduate student submits homework assignments individually.

- TA is here to help you. If you have questions regarding your homework, **TA is your first aid**. If you have questions regarding homework grading, also check with your TA. However, if you don't get satisfactory response, be sure to discuss with Dr. Wu.

Mid-term Exam Policy: Smile☺, graduate students can choose not to take midterms, if you choose to conduct a literature review (see details in **Project**)

Project Policy: Select an industry (that may have various pollutants) or a pollutant (that may be present in various industries). Identify the major air pollution problems generated by that industry (if you choose an industry), the regulations (Federal/State/Local, EPA/OSHA) and control techniques that can be applied to handle those pollution problems. If you choose a pollutant, identify the industries that may generate that pollutant, the regulation (Federal/State/Local, EPA/OSHA) and control techniques that can be applied to handle that pollutant. You should also discuss the health effects and environmental impact resulting from the pollution. A **tour** to a real facility should be part of the project. You are encouraged to present your project in the annual EES Student Poster Competition to be held in spring. Below are examples of the industries/pollutants (though not limited to):

- Food (coffee, meat smokehouse, bread baking, beer, wine)
- Health care facility, Hospital
- Agriculture (sugarcane, citrus, saw mill)
- Sewage sludge treatment, cremation
- Petroleum, natural gas, home furnace, waste-to-energy, integrated gasification combined cycle (IGCC)
- Evaporation loss (dry cleaning, surface coating, asphalt, textile printing)
- Chemical process (carbon black, explosives, paint, soap & detergent, pharmaceutical, pulp & paper)
- Metallurgical (iron & steel mill, metal smelting, battery, welding)
- Mineral products (phosphate fertilizer, brick, gypsum, cement, glass)
- Mercury, dioxin, soot, Cr^{6+}, CO, CO_2, airborne allergens
- Environmental tobacco smoke, secondhand smoke, thirdhand smoke, flame retardants, 3D-printer emission

A **2-Page Proposal** (1.5 line spacing, 12 Times New Romans, 1 inch margin on each side, letter size paper, no hand writing) should be submitted to Dr. Wu. Each group should discuss with Dr. Wu before the final topic is determined, since each topic is allowed for one group only. A **2-Page Midterm Progress Report,** a **12-page Final Project Report,** and **a Final Project Presentations** are required, and their due dates are listed at e-Learning. Submit 1 hard copy per team with 1 electronic copy per person for your final report; the hard copy with comments can be picked up after grading.

The final report should be **reviewed** by one other group before submitted to Dr. Wu. It's the group's responsibility to arrange the review done before their submission, and the reviewers should sign on the draft (which should be submitted, too). 3% of your project's final grade is based on the inclusion of the review, and 2% of your project final grade is based on your review of other's report. The purpose of this review is to get comments/suggestions from your classmates (regarding content, format, flow, etc.), and you certainly should incorporate the comments/suggestions in the final version to be submitted. The weighting of the grade: proposal 15%, midterm progress report 10%, final presentation 35% and final report 35%, report review by other group 3%, review of other group's report 2%. Guidelines for the proposal/reports/presentation are available at e-Learning.

Additionally, a group can propose to develop **a Website** for the project. A maximum bonus of **20% of the project grade** will be awarded to the Website. Any group who would like to develop the Website needs to inform Dr. Wu by the midterm progress report dead line; any notice after the midterm progress report will not be considered. Use your creativity to design your website an attractive one; a simple conversion of your project report or project presentation (e.g. PowerPoint slides) into an html page will not be awarded the bonus point. Furthermore, any group who creates a **YouTube** in place of their presentation can also get a maximum bonus of 25% of the project grade. The group can then use their scheduled presentation time for other activities to help the class learn more about your project. Similarly, the group needs to inform Dr. Wu by the midterm progress report dead line, if the YouTube Video is in its plan. The video should be no more than 20 minutes in length. You can record your formal presentation in the conventional fashion, but you definitely have the freedom if you want to use your creativity to make an informative and attractive video in a novel way. The YouTube Video or web page should be up and **running by noon on Thanksgiving Sunday** so it can be reviewed by others before presentation in class.

Graduate students can also elect to conduct individually a **literature review of advanced air pollution control technologies** in lieu of the **midterms**. At minimum 20 patents or journal articles should be reviewed. The same weighing scheme and deadlines as the group project apply, except that there is no final presentation and the final report counts 70%. Discuss with Dr. Wu your topic before the proposal.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
In-class design	.1-1	12%
Homework Sets (30)	80-120 each	18%
Pre-Class Quizzes (16)	5 each	4%
Post-Class Quizzes (16)	8 each	16%
Midterm Exams (3)	100	30%
Term Project	100	20%
		100%

Grading Policy

Percent	Grade	Grade Points
95.0 - 100	A	4.00
90.0 – 94.9	A-	3.67
85.0 - 89.9	B+	3.33
80.0 - 84.9	B	3.00
75.0 - 79.9	B-	2.67
70.0 - 74.9	C+	2.33
65.0 - 69.9	C	2.00
60.0 - 64.9	C-	1.67
55.0 - 59.9	D+	1.33
50.0 - 54.9	D	1.00
45.0 – 49.9	D-	0.67
0 - 44.9	E	0.00

More information on UF grading policy may be found at:
http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter, which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation
Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at https://evaluations.ufl.edu/evals. Evaluations are open during the last two weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at https://evaluations.ufl.edu/results/.

University Honesty Policy
UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Software Use
All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy
There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see:
http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:
If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.ufl.edu/.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall*,* 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints*:* http://www.distance.ufl.edu/student-complaint-process.