Engineering Faculty Document No.
12-25 May 28, 2024

TO: The Faculty of the College of Engineering
FROM: The Division of Environmental and Ecological Engineering
SUBJECT: New Graduate Course, EEE 51601, Indoor Air Quality

The Faculty of the Division of Environmental and Ecological Engineering has approved the following new course which will be cross-listed with CE. This action is now submitted to the Engineering Faculty with a recommendation for approval.

EEE 51601: Indoor Air Quality
Sem. 2, Lecture 2, Credits 3
Prerequisites: no
Instructor permission required for undergraduates

Course description:
The course covers the fundamentals of indoor air pollutant dynamics in buildings and their heating, ventilation, and air conditioning systems. The course introduces material balance models to mechanistically evaluate pollutant transport dynamics in buildings; fundamental principles of aerosol physics to characterize the behavior of indoor aerosols from several nanometers to tens of micrometers in size; human exposure assessment for indoor aerosols; and analysis of the effectiveness of engineering control strategies for indoor air pollution. The course includes a semester-long course project on an experimental and/or modeling study on indoor air quality and aerosols.

This course has been taught has CE 59700/EEE 59500 for a number of years.

Reasons: Creating a new course and cross listing it with CE.

John W. Sutherland, Professor and Fehsenfeld Family Head
Division of Environmental and Ecological Engineering

EEE 51601: Indoor Air Quality
Level: Graduate

Course Instructor: Brandon Boor

Course Description
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Learning Outcomes & Learning Objectives
1. Mechanistically evaluate pollutant transport dynamics in buildings through application of material
2. balance models.
3. Apply fundamental principles of aerosol physics to characterize the behavior of indoor aerosols from
4. several nanometers to tens of micrometers in size.
5. Evaluate human exposure to indoor aerosols and analyze the effectiveness of engineering control
6. strategies for indoor air pollution.
7. Read and critically analyze papers in the technical literature on indoor air quality (IAQ) and aerosols.
8. Gain additional insight regarding specific topics related to IAQ and aerosols through a rigorous course
9. project.
10. Analyze, and discuss in a group-setting, contemporary IAQ issues facing our global society.
11. Prepare and review written and oral technical communication.

Previous Teaching:
This course has been taught as CE 59700/EEE 59500. What follows is the total enrollment and EEE portion of it.

Spring 2023 – total enrollment 20 with 2 EEE students
Spring 2022 - total enrollment 18 with 2 EEE students
Spring 2021 - total enrollment 16 with 2 EEE students
Spring 2019 - total enrollment 14 with 1 EEE students

The syllabus for Spring 2023 follows.

CE 597/EEE 51601: Indoor Air Quality

Spring 2023, TR: 13:30 – 14:45, ME 1015

Instructor: Dr. Brandon E. Boor, Associate Professor
Office: ArchE Teaching Lab – HAMP G159
E-mail: bboor@purdue.edu
Office Hours: By appointment.

Prerequisites: Graduate standing with an undergraduate degree in engineering or consent of instructor. Qualified undergraduate students may enroll with consent of instructor.

Course Materials: Purdue University Brightspace.

Course Objectives

By taking this course you will be able to:

1. Mechanistically evaluate pollutant transport dynamics in buildings through application of material balance models.
2. Apply fundamental principles of aerosol physics to characterize the behavior of indoor aerosols from several nanometers to tens of micrometers in size.
3. Evaluate human exposure to indoor aerosols and analyze the effectiveness of engineering control strategies for indoor air pollution.
4. Read and critically analyze papers in the technical literature on indoor air quality (IAQ) and aerosols.
5. Gain additional insight regarding specific topics related to IAQ and aerosols through a rigorous course project.
6. Analyze, and discuss in a group-setting, contemporary IAQ issues facing our global society.
7. Prepare and review written and oral technical communication.

Textbook – Required

Hinds, W.C. and Zhu, Y. (2022). *Aerosol Technology: Properties, Behavior, and Measurement of Airborne Particles*, 3rd Edition. Wiley [Online access for 2nd Edition available through Purdue Libraries].

Additional References

Kulkarni, P., Baron, P.A., and Willeke, K. (Eds.) (2011). *Aerosol Measurement: Principles, Techniques, and Applications*, 3rd Edition. Wiley [Online access available through Purdue Libraries].

Seinfeld, J.H. and Pandis, S.N. (2016). *Atmospheric Chemistry & Physics: From Air Pollution to Climate Change*, 3rd Edition. Wiley [Online access available through Purdue Libraries].

Relevant Academic Journals

Environmental Science & Technology, Journal of Aerosol Science, Aerosol Science & Technology, Indoor Air, Building & Environment, Atmospheric Environment, Atmospheric Chemistry & Physics, Environmental Health Perspectives, Atmosphere, Journal of Exposure Science & Environmental Epidemiology, Journal of Hazardous Materials, Annals of Work Exposures & Health, Environmental Science: Processes & Impacts, Environmental Science: Atmospheres, Science & Technology for the Built Environment.

Grading

The overall course grade will be weighted as follows:
Homework Assignments: 45%
Course Project: 45%
Readings and Discussions on Contemporary IAQ Issues: 10%

The plus/minus grading system will be used (e.g. 96.7% and up = A+; 93.3% to 96.7% = A; 90.0% to 93.3% = A-; 86.7% to 90.0% = B+; 83.3% to 86.7% = B; 80.0% to 83.3% = B-). Modifications to this breakdown will be made at the instructor's discretion.

Homework Assignments
There will be three homework assignments over the course of the semester. All assignments are due at the beginning of class for the assigned day. Homework assignments should be completed individually. Students must submit their assignment in the form of an electronic PDF to Brightspace (filename: FirstName_LastName_HW_No.pdf). Students are encouraged to use MATLAB and Microsoft Excel to complete their assignments.

Course Project
You will work in teams to investigate any one of several topics relevant to the course. You will be able to choose from a list of topics provided by the instructor, or you may propose your own topic (with permission from the instructor). The project will include several deliverables to be submitted throughout the semester. Students are expected to complete a rigorous study of the topic (including a review of existing literature), prepare a final written report of the findings in the form of a 10- to 12-page conference/journal paper, and give an oral presentation to your classmates during the last week of the semester. You are expected to integrate course material to complete the course project and to demonstrate a firm understanding of project materials as reflected in the final written report and oral presentation.

Readings and Discussions on Contemporary IAQ Issues
Throughout the semester we will discuss readings on various IAQ topics, listed below. You will have one week to read the assigned paper(s) on the given topic. You will prepare a 500-word reflection on the reading and then discuss the reading with a group of four to five other students via Zoom. Each group will then present a summary of their Zoom discussion to the rest of the class during lecture. The aim of these assignments is to encourage you to think about IAQ issues in a broader scientific and societal context, introduce you to the writings of leading experts in the field, and give you practice discussing technical literature with your peers.

1. Transmission and Mitigation of COVID-19 in Buildings
2. Biomass Cookstoves: IAQ in a Global Context
3. Chemistry of Indoor Environments
4. Microbiology of the Built Environment
5. Indoor Nanoaerosols: Sources & Exposure
6. Emerging IAQ Sensing Technologies
7. Buildings as a Source of Urban Air Pollutants

Attendance
This course follows Purdue's academic regulations regarding attendance, which states that students are expected to be present for every meeting of the classes in which they are enrolled. When conflicts or absences can be anticipated, such as for many University-sponsored activities and religious observations, the student should inform the instructor of the situation as far in advance as possible. For unanticipated or emergency absences when advance notification to the instructor is not possible, the student should contact the instructor as soon as possible by e-mail. When the student is unable to make direct contact with the instructor and is unable to leave word with the instructor's department because of circumstances beyond your control, and in cases of bereavement, quarantine, or isolation, the student or the student's representative should contact or go to the Office of the Dean of Students website to complete appropriate forms for instructor notification. Under academic regulations, excused absences may be granted for cases of grief/bereavement, military service, jury duty, and parenting leave. For details, see the Academic Regulations & Student Conduct section of the University Catalog website. The use of cell phones during lecture is prohibited. Tablets or laptops with a stylus

(e.g. iPad Pro or Microsoft Surface) are permitted for notetaking. Spring 2023 semester holidays (no lecture): Spring Vacation (March 14 and 16, 2023).

Academic Guidance in the Event You are Quarantined/Isolated due to COVID-19
If you must miss class at any point in time during the semester, please reach out to me via e-mail so that we can communicate about how you can maintain your academic progress. If you find yourself too sick to progress in the course, notify your advisor and notify me via e-mail. We will make arrangements based on your particular situation. Importantly, if you find yourself too sick to progress in the course, notify your advisor and notify me via e-mail. We will make arrangements based on your particular situation. The Office of the Dean of Students (odos@purdue.edu) is also available to support you should this situation occur.

Lecture Notes
Basic lecture PDFs will be prepared and uploaded to Brightspace prior to each class together with blank space for hand-written notes given in real-time by the instructor using an iPad Pro. You are responsible for printing and bringing the lecture PDFs to class and documenting all hand-written notes by the instructor during lecture. It is recommended that you print the notes (1 slide per page) ahead of class or use a tablet with a stylus for note-taking (PDF Expert or similar is recommended).

E-mail Communication
All e-mails directed to the instructor must be written in a professional manner.

Course Evaluation
During the last two weeks of the semester, you will be provided with an opportunity to give feedback on this course and your instructor. Purdue uses an online course evaluation system. You will receive an official e-mail from evaluation administrators with a link to the online evaluation site. You will have up to 13 days to complete this evaluation. Your participation is an integral part of this course, and your feedback is vital to improving education at Purdue University. I strongly urge you to participate in the evaluation system.

Academic Integrity
Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either e-mailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information that is submitted provides the greatest opportunity for the university to investigate the concern.

Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty" [Part 5, Section III-B-2-a, University Regulations]. Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest" [University Senate Document 72-18, December 15, 1972].

Purdue Honors Pledge
As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do.
Accountable together - we are Purdue.

Grief Absence Policy for Students
Purdue University recognizes that a time of bereavement is very difficult for a student. The University therefore provides the following rights to students facing the loss of a family member through the Grief Absence Policy for Students (GAPS). GAPS Policy: students will be excused for funeral leave and given the opportunity to

earn equivalent credit and to demonstrate evidence of meeting the learning outcomes for missing assignments or assessments in the event of the death of a member of the student's family.

Counseling and Psychological Services (CAPS)
Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 and http://www.purdue.edu/caps/ during and after hours, on weekends and holidays, or by going to the CAPS office of the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Students with Disabilities
Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let the instructor know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

Emergencies
In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructor via e-mail. You are expected to read your @purdue.edu e-mail on a frequent basis.

Diversity and Inclusion
Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life.

Purdue University prohibits discrimination against any member of the University community on the basis of race, religion, color, sex, age, national origin or ancestry, genetic information, marital status, parental status, sexual orientation, gender identity and expression, disability, or status as a veteran. The University will conduct its programs, services, and activities consistent with applicable federal, state, and local laws, regulations and orders and in conformance with the procedures and limitations as set forth in Executive Memorandum No. D-1, which provides specific contractual rights and remedies. Any student who believes they have been discriminated against may visit http://www.purdue.edu/report-hate to submit a complaint to the Office of Institutional Equity. Information may be reported anonymously.

CE 597/EEE 595 Lecture Schedule – Spring 2023 (*Revision: January 04, 2023*)

Lectures	Dates	Topics Covered	Textbook Reading
1-2	Jan. 10, 12	Course introduction and project overview, indoor aerosols and gases, the material balance principle	--
3-6	Jan. 17, 19, 24, 26	Material balance models for buildings	--
7-9	Jan. 31, Feb. 02, 07	Particle size distributions	S&P Ch.8*
10-14	Feb. 09, 14, 16, 21, 23	Properties of gases, rectilinear particle motion, particle size definitions, inertial impaction	Hinds Ch. 2, 3, 5
15-16	Feb. 28, Mar. 02	Brownian motion and diffusion	Hinds Ch. 7
17-18	Mar. 07, 09 (No class Mar. 14, 16)	Particle deposition to indoor surfaces	--
19-20	Mar. 21, 23	Adhesion and resuspension	--
21-23	Mar. 28, 30, Apr. 04	Filtration and air cleaning	Hinds Ch. 9
24-26	Apr. 06, 11, 13	Exposure assessment, intake fraction, and lung deposition models	--
27-28	Apr. 18, 20	Nucleation, condensation, and coagulation	--
29-30	Apr. 25, 27	Course project presentations and final reports due May 01.	

*Chapter 8 from Seinfeld & Pandis (S&P) will be posted to Brightspace.