Novel Air Quality Measurement Techniques CE 397 Fall 2019

The University of Texas at Austin
Department of Civil, Architectural, and Environmental Engineering

Course Unique Numbers: 15564
Course Website: https://utexas.instructure.com/courses/1266061
Classroom and Time: ECJ 3.122 Tuesday 12:30 – 2:00 pm, Thursday 12:30 – 2:00 pm
Prerequisites: Graduate student. For undergraduate students: CE369R or consent of instructor.
Instructor: Dr. Pawel Misztal
Office: ECJ 5.428
Phone: 512-232-5840
e-mail: misztal@utexas.edu
website: https://sites.utexas.edu/MisztalLab/

Office Hours: Tuesday and Thursday 2:00 PM - 3:00 PM or by appointment.
While these are the standard office hours, I am *always* happy to speak with students in my office if the door is open or if encountered in the hallway. Appointments are welcome too.

Course Catalog Description: Technological advancements in measurements of indoor and outdoor air quality. Operation principles of novel real-time trace-gas sensors and mass spectrometers. Air quality measurements at different spatiotemporal scales: *hands-on* use of analytical instrumentation, data acquisition and data processing.

Course Summary:
Students will gain practical knowledge and experience how to pose their air quality questions and address them through taking hands on measurements. The instruments of focus would be mass spectrometers measuring real-time gas-phase chemistry as well as other real-time sensors (e.g. ozone, wind data, CO2, particles, carbon monoxide, etc). This course has both theoretical and laboratory character, as well as it could include excursions to measurement sites such as a test house, environmental chambers or an outdoor field site where measurements would be made (e.g. landfill, agricultural or forested site). A field study will be designed by students who would independently measure volatile organics from various indoor and outdoor sources. These exercises will expand the conceptual understanding of environmental sources and sinks of volatile organic compounds, will encourage synthetic and analytical thinking, and will give students a sense of achievement as an experimentalist. Automation approaches are important for the success of the efficient experimental planning and design and the students will learn programming concepts of automations of both data acquisition and data processing.

Course Objectives and Student Outcomes:
1. An ability to identify major chemical exposure sources indoors and outdoors and motivations for air quality measurements
2. An ability to familiarize with concepts of instrument's time resolution, chemical completeness, and chemical selectivity to guide appropriate tools for tackling general and specific air quality problems.
3. An ability to understand the principles of real-time and time-integrated analytical instruments applied to air quality measurements indoors and outdoors.
4. An ability to design an experiment to identify major volatile emission sources, characterize chemicals emitted from different materials (e.g. consumer care products) and/or chemical processes (e.g. cell metabolism).
5. An ability to conduct supervised hands-on measurement of comprehensive chemical composition from various sources and materials.

6. An ability to determine emission and/or uptake rates of different gaseous pollutants using a flow-through chamber and at larger scales indoors (e.g. classroom) and outdoors (e.g. tower).
7. An ability to connect knowledge by attending a field trip to a measurement site or industrial facility where air quality is monitored.
8. An ability to analyse data using manual, semi-automated and fully automated programming approaches to inform about abundant volatile pollutants, composition of sources, and air quality.

Textbooks and supplemental reading materials:
Students are encouraged to read provided papers and refer to textbooks to broaden air quality measurement aspects and interests. However, specific handouts and reading assignments may be provided as tailored to the specific topics.

References:
Koppmann, R.: Volatile Organic Compounds in the Atmosphere, John Wiley & Sons, 2008. ISBN: 978-1-405-13115-5
Ellis, A.M. and Mayhew, C.A., 2013. Proton transfer reaction mass spectrometry: principles and applications. John Wiley & Sons. ISBN 9781118682883
Nazaroff, W.W. and Goldstein, A.H., 2015. Indoor chemistry: research opportunities and challenges. Indoor Air, 25(4), pp.357-361.
Salthammer, T., Zhang, Y., Mo, J., Koch, H.M. and Weschler, C.J., 2018. Assessing human exposure to organic pollutants in the indoor environment. Angewandte Chemie International Edition, 57(38), pp.12228-12263.
Nazaroff WW, Weschler CJ. Cleaning products and air fresheners: exposure to primary and secondary air pollutants. Atmospheric Environment. 2004 Jun 1;38(18):2841-65.
Tang, X., Misztal, P.K., Nazaroff, W.W. and Goldstein, A.H., 2016. Volatile organic compound emissions from humans indoors. Environmental science & technology, 50(23), pp.12686-12694.
Misztal, P.K., Lymperopoulou, D.S., Adams, R.I., Scott, R.A., Lindow, S.E., Bruns, T., Taylor, J.W., Uehling, J., Bonito, G., Vilgalys, R. and Goldstein, A.H., 2018. Emission factors of microbial volatile organic compounds from environmental bacteria and fungi. Environmental science & technology, 52(15), pp.8272-8282.
Gall, E., Darling, E., Siegel, J.A., Morrison, G.C. and Corsi, R.L., 2013. Evaluation of three common green building materials for ozone removal, and primary and secondary emissions of aldehydes. Atmospheric environment, 77, pp.910-918.
Twilley, N. The Hidden Air Pollution in Our Homes. The New Yorker, April 1, 2019.

Topics:
Theoretical

1.	Course introduction and background	0.5 wk
2.	Chemical exposure sources around us	0.5 wk
3.	Measurements of air quality at different spatiotemporal scales	1.5 wks
4.	Operation principles of trace gas analysers and mass spectrometers	2.5 wks
5.	Designing experiments to measure indoor air quality in various environmental contexts	2 wk

Hands-On

6.	Building and testing an emission-rate measurement setup (aka a “sniffing” experiment)	1 wk
7.	Measurement of emission rate of different trace gases from different materials (e.g. wood, consumer care products, beer, sodas)	2 wk
8.	VOC measurements in a classroom or the UTestHouse.	1 wk
9.	Excursion to a measurement facility at JJ Pickle	

or a field/industrial site	1 wk
10. Data analysis: automation, quality control, interpretation	1.5 wk
11. Summary and the future of air quality measurements	0.5 wk
	Total: 14 wks

Grading:

Classroom Participation (attendance)	5%
Midterm Test 1	15%
Midterm Project	10%
Midterm Test 2	15%
Final Project & Presentation	30%
Homework Assignments	25%
	Total: 100%

Course Letter Grades (for graduate and undergraduate students):
90-93, >93 A-, A
80-83, >83-86, >86-90 B-, B, B+
70-73, >73-76, >76-80 C-, C, C+
60-63, >63-66, >66-70 D-, D, D+
< 60 F

Personal Problems:
Illnesses or personal problems need to be reported to me as soon as possible by email, phone or in person, so I can try to help, excuse the absence and provide study-at-home materials. “After-the-fact” notification cannot typically be excused unless in an emergency.

Honor Code:
The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the university is expected to uphold these values through integrity, honesty, thrust, fairness, and respect towards peers and community.

Policy of Scholastic Dishonesty:
Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University. Since such dishonesty harms the individual, all students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced. For further information, visit the Student Judicial Services web site http://deanofstudents.utexas.edu/sjs/.

Privacy – Web Based Class Sites:
Web-based, password-protected class sites may be associated with all academic courses taught at the University. Syllabi, handouts, assignments and other resources are types of information that may be available within these sites. Site activities could include exchanging email, engaging in class discussions and chats, and exchanging files. In addition, electronic class rosters will be a component of the sites. Students who do not want their names included in these electronic class rosters must restrict their directory information in the Office of the Registrar, Main Building, Room 1. For information on restricting directory information, see: http://www.utexas.edu/student/registrar/catalogs/gi00-01/app/appc09.html.

Accommodations (Disability Statement):
The University of Texas at Austin provides, upon request, appropriate academic accommodations for qualified students with disabilities. For more information, contact the Division of Diversity and Community Engagement, Services for Students with Disabilities, 471-6259 (voice) or 232-2937 (video phone) or http://www.utexas.edu/diversity/ddce/ssd.

Dropping the Course:

Undergraduate Students: From the 1st through the 12th class day, an undergraduate student can drop a course via the web and receive a refund, if eligible. From the 5th through the university's academic drop deadline, a student may Q drop a course with approval from the Dean, and departmental advisor.
Graduate Students: From the 1st through the 4th class day, graduate students can drop a course via the web and receive a refund. During the 5th through 12th class day, graduate students must initiate drops in the department that offers the course and receive a refund. After the 12th class day, no refund is given. No class can be added after the 12th class day. From the 13th through the 20th class day, an automatic Q is assigned with approval from the graduate advisor and the Graduate Dean. From the 21st class day through the last class day, graduate students can drop a class with permission from the instructor, graduate advisor, and the Graduate Dean.

Attendance Policy:
Regular attendance and participation are essential and expected. Random attendance will be taken throughout the semester by various means and it can affect your grade up to 5% (participation grade). "A student who is absent from a class or examination for the observance of a religious holy day may complete the work issued within a reasonable time after the absence, if proper notice has been given". The deadline for notification of such an absence is 14 days prior to the class absence.

Course Evaluations:
Each student will be given the opportunity to evaluate the course and the instructor using the standard course/instructor evaluation form at the end of semester.

Computer Usage:
Some homework assignments and the term projects will require extensive use of computers, chemistry and mass spectrometry reference databases. The basic familiarity of Matlab and LabVIEW is recommended. Some extra tutoring/tutorials will be available for those students.

Final Exam:
This course will not have a final exam. The final project and the final project presentation will replace the final exam.

Projects:
There will be two projects assigned. The midterm projects will count for 10% and final for 30% of your final grade. Midterm project will be an individual project.

Final Project Description:
Hands-on measurements of air quality tailored and guided to individual interests and predetermined research questions prior to the assignment. Example research projects include experimental determination of emission factors of selected compounds from consumer care products, indoor composts, paints, humans, indoor plants, etc. Measurements and data analysis of air quality inside and outside the UTest House, environmental chambers, and other ideas are also possible.
The project report should have a form of an extended abstract and include: (i) Title (needs to relate to air quality), (ii) Goals, (iii) Methods, (iv) Results and discussion, (v) Conclusions. The length should be aimed at between 1000 and 2500 words (the exact word count will not be checked). Figures and tables not included in the word count.

Important Dates:
Test 1: October 1
Midterm project due: November 1
Preliminary results for the final project due: November 12
Test 2: November 19

Final project due: December 3

Due Dates Policy:
All assignments are due at the end of the day and those turned in late will count off 10% per day unless excused or arranged otherwise in advance.

COURSE SCHEDULE

Date	Topics	Due date for
8/29	Course introduction and background	
9/03	Chemical exposure sources around us	HW0
9/05	Measurements of air quality at different spatiotemporal scales I	
9/10	Measurements of air quality at different spatiotemporal scales II	
9/12	Measurements of air quality at different spatiotemporal scales III	
9/17	Operation principles of trace gas analysers and mass spectrometers I	HW1
9/19	Operation principles of trace gas analysers and mass spectrometers II	
9/24	Operation principles of trace gas analysers and mass spectrometers III, + Midterm project assignment	HW2
9/26	Operation principles of trace gas analysers and mass spectrometers IV, + Review for midterm test 1	
10/01	Midterm test 1	Test 1
10/03	Designing experiments to measure air quality I (outdoors)	
10/08	Designing experiments to measure air quality II (indoors)	
10/10	Designing experiments to measure indoor air quality III (indoors)	
10/15	Building an air quality measurement setup (e.g. “sniffing” experiment)	HW3
10/17	Testing an air quality measurement setup + Final project assignment	
10/25 **PRC**	Measurement of emission rates of different trace gases from different materials (construction materials – wood, wallboard, carpet, student ideas)	HW4
10/25 **PRC**	Measurement of emission rates of different trace gases from different materials (consumer products – antiperspirants, shampoos, student ideas)	
11/01 **PRC**	Measurement of emission rates of different trace gases from different materials (food and beverages – sodas, beers, juice, student ideas)	Midterm project
11/01 **PRC**	Measurement of emission rates of different trace gases from different materials (plants - uncut and cut leaves, flowers, mosses)	
11/15 **PRC**	Trace-gas measurements at the UTestHouse	HW5
11/15 **PRC**	Trace-gas measurements at the UTestHouse	
11/19 ECJ	Data analysis: automation, quality control, interpretation	Final project – preliminary results
11/21 ECJ	Data analysis: automation, quality control, interpretation/ Review for Test 2	
11/22	Excursion to a measurement facility at JJ Pickle or a field/industrial site	
11/22	Excursion to a measurement facility at JJ Pickle or a field/industrial site	
11/26	Midterm Test 2	Test 2
11/28	*Thanksgiving Day*	
12/03	Summary and the future of air quality measurements	Final project