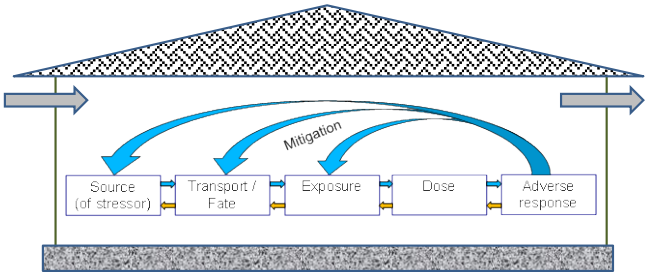
CE369R
Indoor Air Quality



Semester: Spring 2018 **Unique Number**: 14765

Meeting Dates/Times: T Th 12:30 p.m. to 1:45 p.m. **Meeting Location**: CPE 2.206

Instructor

- Richard L. Corsi, Ph.D., PE
- Office: ECJ 9.102A
- Phone:
- Email:
- Tweets about IAQ (and more) @CorsIAQ

Office Hours: T & Th 2:30 to 4:30 p.m. (or by appointment)
The office hours listed above will be the standard office hours. Changes from these on a given T or Th will be stated in advance. Every effort will be made to reschedule office hours for earlier or later in the same day and to retain the same number of available office hours each week during the semester. Additional office hours will be established prior to exams. Appointments are *always* welcome, and unless in a meeting, in route to a meeting, or trying to meet an important deadline, Dr. Corsi is always willing to stop to speak in the hallway or in his office when his door is open. He is also responsive to student emails.

Pre-Requisites
Civil Engineering 311K and 319F; Architectural Engineering 346N or Civil Engineering 341 (or Environmental Engineering 312) *or consent of instructor*.

It is assumed that students in this course can solve basic ordinary differential equations and are proficient in writing computer programs or using spreadsheets.

Textbook
There will not be a textbook for this course. However, required reading will be assigned during the semester. Reading assignments will parallel relevant course content on a weekly basis. Recommended reading will also be listed. Most reading assignments will involve peer-reviewed journal articles. Students will also be required to review published technical literature for term projects.

Course Summary
This course will be taught as a senior-level elective (level I elective) for qualified undergraduate students. It may also be taken as an introductory course on indoor air quality for graduate students, but will not be cross-listed as a graduate course.

The course will focus on the properties, sources, transport and fate, human exposure and adverse responses to a wide range of important indoor air pollutants. For each pollutant, control strategies and engineered technologies will be addressed with respect to avoidance or mitigation of adverse responses to the pollutant. Both gaseous and particulate (liquid and solid) phase pollutants will be considered. The emphasis will be on non-industrial

indoor environments, but many of the underlying principles and tools that will be used in the course are also applicable to other indoor atmospheres as well as the outdoor atmosphere. Pollutants of outdoor origin that are inhaled inside of buildings will be considered, since a large percentage of human exposure to outdoor pollution occurs indoors. Finally, throughout the semester topics of contemporary importance will be woven into lectures. A sequential listing of lecture topics is provided at the end of this syllabus.

Course Format
This course will involve 150 minutes of lecture each week. Lectures will be supplemented by homework assignments and term projects. Outside reading assignments will also be used to supplement lecture material.

Course Outline
See attached list of topics.

Academic/Learning Goals
Students who complete this course should:

1. appreciate the importance of indoor air quality on human health and productivity,
2. become familiar with the general field of indoor air quality, including major institutions and information and data sources,
3. understand the historical context of indoor air quality, particularly with respect to temporal changes in sources and types of indoor air pollution and reasons for such changes, as well as the relevance of such changes on/to society,
4. develop an improved comprehension of technical literature relevant to the field of indoor air quality,
5. understand a large number of indoor air pollutants, their sources, important processes that affect their indoor fate, health effects, and control strategies and technologies (by completion of the course students should become *conversant* on these subjects for numerous indoor pollutants),
6. understand how building-related (design, construction, operation and maintenance) factors and environmental conditions affect indoor air pollution levels, fate, and control, as well as occupant exposures to those pollutants,
7. be able to predict indoor concentrations of air pollutants given knowledge of pollutant and source properties, environmental conditions, and building construction and operation,
8. understand a spectrum of control options for reducing the adverse effects of indoor air pollution, including the completion of calculations to predict the relative effectiveness of these options, and
9. develop an appreciation for contemporary indoor air quality issues,
10. have a lot of fun learning about a very important subject that affects lives on a daily basis.

Assessment of Academic/Learning Goals

Attendance: Regular attendance is recommended and expected. However, attendance will not be used in assigning a student's final grade.

Homework: Homework will be assigned during the semester and will include scientific calculations *and* paper reviews. Each assignment will cover one or more of the major topics listed at the end of this syllabus and will be assigned on an *approximate* weekly to every-other-week basis with one to two weeks to complete the assignment. Some assignments will involve more than problem calculations and may take on the form of "mini projects," sometimes involving teams of students. Homework will generally be assigned on a Thursday and due the next Friday at 1 p.m., unless otherwise stated by the professor. In some cases additional time might be allocated by the professor for completion of homework assignments.

Project: Students will work on teams of 4 (3 if needed) to complete a term project. The project will necessarily involve a detailed review of published literature, and synthesis and use of information to arrive at new knowledge. Each student/team will develop a formal conference paper that conforms to established requirements and will make a 10-20 minute presentation of their findings (time dependent on number of students

in the class and team size) at an *Indoor Air Quality Symposium* at the end of the spring semester. The symposium will be held over two evenings during the last week of the semester and will be open to the greater university community. Some presentations may take place during the regular class meeting time, particularly if any students have a difficult time attending evening symposium sessions. A list of possible term projects will be provided by Dr. Corsi early in the semester. Project teams may choose to work on one of the listed projects or to study a separate topic with approval of Dr. Corsi.

Exams: Two in-term exams will be given. Exam 1 will be given at the normal lecture time on Thursday March 8th. Exam 2 will be given at the normal lecture time on Thursday April 19th. Pending administrative approval this course will not have a final exam; a term-project will be completed in its place.

Evaluation Policy

- Homework 20%
- Exam 1 25%
- Exam 2 25%
- Project 30%

Final marks will include + and – grades, e.g., B+ or A-. The *maximum* cut-offs for marks in this course are:

A	≥ 92%
A -	88 – 91%
B+	84 – 87%
B	75 – 83%
B-	71 – 74%
C+	67 – 70%
C	60 – 66%
< C	< 60%

Teaching Assistants and Graders: This course will have a teaching assistant who will help guide students on an airborne infectious disease transmission team challenge and time-activity analyses, assist with grading of homework assignments, and in some cases provide guidance on term projects.

Students with Disabilities: 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, 512-471-6259 (voice) or 512-410-6644 (video phone) or http://diversity.utexas.edu/disability/

Access to Computers: All students registered for this course must have an email account on the university network. The Department of Civil, Architectural and Environmental Engineering has a microcomputer laboratory, the Learning Resource Center (LRC) on the third floor of ECJ. The LRC is available for student use. Assistants in the LRC are there to operate the microcomputer laboratory and to respond to specific software and hardware problems.

Course Materials: Course materials will be either distributed as hard copies during lecture. Posted on Canvas, or emailed to students enrolled in the course. These materials will include the course syllabus, supplemental material for lectures, homework assignments and solutions, special announcements, and other relevant course materials. Emails related to the course will always have "CE369R" as the start of the subject line.

Course/Instructor Evaluation Plan: During one of the two final meeting periods of the semester students will have an opportunity to evaluate this course and the instructor using approved MEC forms. These forms will be distributed and collected by a student in the class. The instructor will not be present when the forms are

completed. All students are encouraged to attend this meeting and to complete the MEC forms. *Students are also encouraged to speak with the instructor during the semester, and to provide feedback regarding the course.*

Scholastic Dishonesty Policy: A great education is one that involves personal growth and deep intellectual exploration, experienced and performed with academic integrity and honesty. A failure on the latter is a failure to one's self, fellow students, and to the academic institution. Thus, 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. Policies on scholastic dishonesty will be strictly enforced. For further information, visit the Student Judicial Services web site http://deanofstudents.utexas.edu/conduct/.

Instructor Absences: Dr. Corsi is rarely absent for more than 2 lectures in a semester. He will do everything possible not to violate this norm. Any absences will be specified in advance. A guest lecturer will speak during any instructor absences.

Cockrell School of Engineering drop policy

Undergraduate Students- drop policy for long sessions: 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 13th through the 20th class day, an automatic Q is assigned, no refund; approval from the Dean and departmental advisor is required. From the 21st class day through the mid-semester deadline, approval is required from the Dean, instructor of the course and departmental advisor.

Graduate Students- drop policy for long sessions: 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. Students with 20-hr/week GRA/TA appointment or a fellowship may not drop below 9 hours.

TOPICS BY MODULE

This course is divided into two modules. Module 1 focuses on basic concepts and tools that provide necessary background for Module 2. Module 2 focuses on a series of important indoor air pollutants. An outline of topic coverage for each module is provided below.

Module 1 – INTRODUCTORY CONCEPTS & TOOLS

Students will be introduced to the field of indoor air quality, its importance, history, important institutions and relevant information and data sources. Students will also learn about several important tools that will allow prediction of indoor pollutant concentrations, relative contributions of sources of indoor and outdoor origin, and human exposure to indoor pollution, and a general construct for assessing control strategies.

- Introduction to the Field of Indoor Air Quality
  - Indoor air quality and its importance (intellectual merit and broader impacts)
  - Historical perspective (major changes and developments over time)
  - Major indoor pollutants and sources
  - Important processes and building features (including human occupants)
  - Institutional framework & information sources

- Air and Pollutant Concentration Units
  - Composition of dry air and differences with outdoor air
  - Air as an ideal gas
  - Concentration units of gaseous pollutants
  - Concentration units for particulate matter

- Mass Balances on Indoor Spaces
  - Basic mass balance models
  - Simple steady-state solution w/ analysis of important terms and variable
  - Dynamic solution and analysis of terms
  - Time to reach steady-state (& implications for various indoor sources and conditions)
  - Introduction of removal terms into mass balance equations (& analysis of new terms and variables)
  - Overview: Multi-zone modeling (two-zone example)
  - Overview and examples: Near source (Pig Pen) effects

- The Human Respiratory System
  - Important features of the respiratory system
  - Inhalation and exhalation rates
  - Carbon dioxide and moisture releases
  - Carbon dioxide and air exchange measurements

- Intake Fraction (IF) as a Source and Stressor Assessment Tool

Module 2 – INDOOR AIR POLLUTANTS

Students will be introduced to a series of important indoor air pollutants. For each pollutant, lectures and related class discussions will focus on *important properties* of the pollutant*, health effects* and other adverse responses to the pollutant inside buildings, e.g., soiling of important artifacts, *sources* of the pollutant*, fate and transport* of the pollutant, including homogeneous reactions and surface interactions, and appropriate *control strategies* and technologies. Specifics related to each of these topics vary widely between pollutants and are omitted from the descriptions below for brevity.

- Particulate Matter (PM)
- Airborne Infectious Disease Transmission
- Volatile Organic Compounds (VOCs) including formaldehyde
- Ozone (O_3) and Associated Reaction Products
- Semi-Volatile Organic Compounds (SVOCs)
- Radon (Rn)
- Carbon Monoxide (CO) and Nitrogen Dioxide (NO_2): Combustion Pollutants

- Additional contemporary issues relevant to indoor air quality (time permitting)
  e.g., Indoor air quality in schools; Building decontamination chemistry; Freeways & indoor air quality; Water to indoor air pollution

Term Project Requirements and Ideas
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Students will work in groups of 3 or 4 (preferable) to complete a term project. The project will necessary involve a review of published literature on a specific issue related to indoor air quality, synthesis of information/data, and analysis that leads to new knowledge.

Each project will have two major deliverables. Major deliverable 1 will be a conference paper that conforms to prescribed conference requirements. Major deliverable 2 will be a formal presentation at an end-of-term symposium held over evenings the last week of the semester.

Conference Paper: Each team will submit a conference paper that describes the project topic, methods, and results. The paper must have a title followed by an *abstract* (less than 250 words), list of five *keywords* (none of these should be in the title of the paper), statement of *implications* (concise statement of why the paper is important – 100 words maximum), *Introduction* section that explains the issue being studied and background information to support the effort (including references to past work on the topic, research gaps, etc.), *Methods* section that describes the approach used to address the problem (this section should also include any models developed for the study, data analysis methods, etc.), *Results and Discussion* section that describes project results with a well-organized discussion of their meaning and relationship to past work, *Conclusions* section that concisely states the major conclusions of the research, and a *References* section. A template will be provided.

References cited in the text and listed in the References section must conform to the format of the journal *Indoor Air*.

Papers should be submitted as double-spaced with consecutive line numbering. The font must be Times New Roman at 12 point. Margins must be 1" on all sides. All equations, tables, and figures should be consecutively numbered.

The total word count of the paper must not exceed 6,500. Tables and figures count as 200 words each.

Papers will be graded based on depth of investigation (15%), technical correctness of approach and interpretation of results (40%), appropriate reference to past work (15%), organization (15%), English grammar (7.5%), and conformance to stated requirements (7.5%)

Symposium Presentation: Each team will deliver a 15 to 20 minute presentation (to be decided based on number of teams) with a 3 minute period for questions and answers thereafter. Presentations will be made using PowerPoint slides that will be submitted to Dr. Corsi following the presentation. Presentations will be evaluated based on quality of slides (25%), organization of presentation (30%), quality of oral presentation (30%), and responses to audience questions (15%). Symposium presentations will be made on campus during the last week of the semester. The symposium will be held over two evenings (pizza provided by Corsi). Accommodations will be made for groups with a team member who cannot attend evening presentations (presentations for these teams will occur during regular class meeting times the last week of the semester).

Final papers will be due on Friday May 4th by 3 p.m. (electronic copy emailed to Dr. Corsi).

Corsi's Rules for PowerPoint Presentations

1. Plan your story. You want to hold the audiences hand and guide them through your work.
2. Be passionate about the issue you are speaking about and your findings.
3. Be professional. Avoid "silly" images on slides, etc.
4. Avoid excessive amount of words on slides. The Corsi rule is 26 words maximum for a slide (Corsi sometimes violates this by a few words). You do NOT have to make complete sentences to get points across. Put the main point in words and fill in the rest. For example (the first bulleted line below could easily be stated by the second line):

    - Buildings are responsible for consuming 40% of all energy used in the United States

    - Buildings = 40% of energy use

5. Avoid wrap around text lines. Corsi hates these.
6. Font size should be 24 to 28 for primary lines and 20 to 24 for secondary lines
7. Make sure that your slides are "neat" and consistent. This is particularly important when you have multiple presenters. Use the same template, etc.
8. During your presentation you will likely turn to your slide to point out important findings. Do not point at the computer monitor at the podium. The audience cannot see the monitor. Whenever you turn to look at the screen, remember to raise your voice so that the audience can hear you.
9. Do not mumble under your breath. If you screw something up, do not worry about it .... correct what you said and move on.
10. Do your best to maintain eye contact with your audience.
11. Keep your hands out of your pockets!
12. Maintain good rapport with your audience during the question and answer period. When someone asks a question it is fine to say "That's a really good question." Also, it is good to repeat a question in case the audience did not hear it before your answer.
13. Be calm. You are speaking to your classmates, and your professor is a pretty nice person --- he wants this to be a good (and fun) experience for everyone.
14. Practice to make sure that you finish within the time limit. You will be cut-off during the time limit and do not want to rush 5 minutes of material into the last 30 seconds.