CE 396L.6: Human Exposure to Indoor Air Pollution

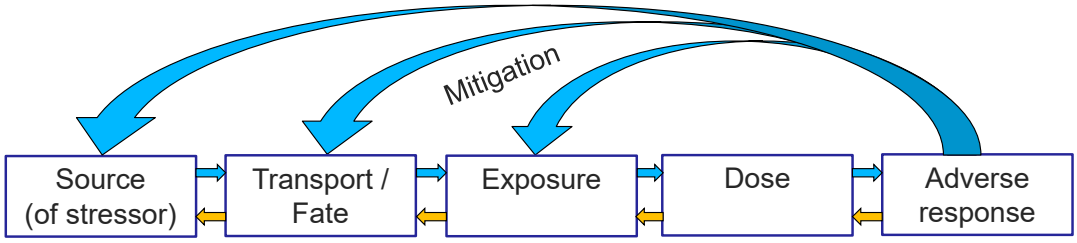
Semester: Spring 2012 **Unique Number**: 15800

Meeting Dates/Times: T Th 11:00 a.m. to 12:15 p.m. **Meeting Location**: ECJ 5.418

Instructor: Richard L. Corsi, Ph.D., PE **Office Hours**: T Th 1:00 to 3:30 p.m.

- Office: ECJ 9.102G
- Phone:
- Email:

Pre-Requisites: Graduate standing or consent of instructor.



Textbook: There will not be a textbook for this course. A list of required and recommended reading materials will be made available to students during the semester, with postings on Blackboard. Students will also be required to review published literature for term projects.

A good reference textbook on exposure analysis is *Exposure Analysis* by Ott, Steinemann, and Wallace (Taylor and Francis – ISBN = 1-56670-663-7).

Course Summary: This course will focus on human inhalation exposure to pollution in both the gaseous and particle (liquid and solid) phases. The emphasis will be on non-industrial indoor environments, but the underlying principles and tools will be directly applicable to all environments, particularly the outdoor atmosphere, and pollutants of outdoor origin that are inhaled inside of buildings will be important to the course. While the emphasis is on inhalation exposure, some of the course concepts are relevant to all exposure routes. Course material will include fundamental tools and concepts associated with inhalation exposure analysis, with an emphasis on exposure modeling and predictions for a spectrum of important air pollutants.

Course Format: Lectures will be supplemented by homework assignments and a term project. Outside reading assignments and two take-home exams will also be used to supplement lecture material. Students are expected to select a topic for a term project relatively early in the semester (project selection by February 16th) and to research the subject throughout the semester. Homework assignments will not be given the last three weeks of the course so that students can work on completion of their term projects.

Course Outline: See attached list of topics.

Academic/Learning Goals: Students who complete this course should:

- learn a number of tools that are used to assess individual and population exposures to air pollutants.
- develop an appreciation and understanding of a broad spectrum of issues in human exposure science, particularly as related to inhalation exposure to air pollutants,
- become familiar with information sources related to human exposure to air pollution, and
- improve comprehension relevant to the published literature related to exposure science.

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 in class. Homework will include scientific calculations and paper reviews. Depending on the size of the class, at least one homework assignment (2012 Flu Challenge) might be assigned to teams of students. The 2012 Flu challenge will count as 2 homework assignments. 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 and bi-weekly basis with one week to complete the assignment.

Term Project: Each student (or teams of two students depending on class size) will select, in consultation with the instructor, a specific project that will be completed over the course of the semester. The project will necessarily involve a detailed review of published literature, and synthesis and use of information to arrive at new knowledge. Each student will contribute to a journal manuscript that conforms to the requirements of the *Journal of Exposure Science and Environmental Epidemiology*. Each student will also make a 10 to 20 minute presentation of their findings (time dependent on number of students in the class) at an "Inhalation Exposure Symposium". Depending on the class size, the symposium will either be held during the normal lecture time and room during one or both of the last two meetings for the semester OR over one or two evenings during the last week of the semester. More information and examples of possible term projects will be posted on Blackboard and discussed during lecture early in the semester.

Exams: Two take-home exams will be given during the semester. Students will have 48 hours to complete each exam (given on Tuesday in lecture and returned the next lecture). Pending departmental approval there will not be a final exam in this course.

Evaluation Policy

• Homework (weekly to bi-weekly)	30%	Dates: weekly to bi-weekly.
• Exam 1 (*given T Feb 28th*)	20%	Date: given Tuesday 2/28 & returned Thursday 3/1
• Exam 2 (*given T April 12th*)	20%	Date: given Tuesday 4/12 & returned Thursday 4/14
• Term project	30%	Date: final paper due Friday 5/4 presentation on last week of semester

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 is not assigned support for a teaching assistant or grader. The instructor will do all grading of assignments, projects, and exams.

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, 471-6259 (voice) or 232-2937 (video phone) or http://www.utexas.edu/diversity/ddce/ssd

Access to Computers: All students registered in this course must have an email account on the university network. You may use your existing account or you may obtain a University email account. I will be communicating via email with the class a lot (you might even get sick of me!). 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 you to use. Assistants in the LRC are there to operate the microcomputer laboratory and to respond to specific software and hardware problems.

Course Materials on Blackboard: Course materials will be posted on the CE396L.6 electronic *Blackboard* site throughout the semester. These materials will include the course syllabus, supplemental material for lectures, homework assignments and solutions, special announcements, and other relevant course materials. Students should become familiar with the CE396L.6 *Blackboard* site.

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. I will not be present when the forms are being completed. All students are encouraged to attend this meeting and to complete the MEC forms. *Students are encouraged to speak with me during the semester, and to provide feedback regarding the course. This is a sincere statement. Your input is important to me.*

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://www.utexas.edu/depts/dos/sjs/.

Instructor Absences: The instructor is typically absent from 0 to 2 lectures in any given semester. Absences will be specified in advance. A guest lecturer may 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 School drop policy
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.**

COURSE TOPICS

(shown here in chronological order of coverage & approximate week of coverage; Week 9 = spring break)

EXPOSURE SCIENCE (definitions and fundamental concepts) – Week 1

- Exposure defined
- Exposure pathways
- Aggregate and cumulative exposures
- Exposure analysis (interconnected components)
- Inhalation exposure (definition; relative importance)
- Relative inhalation exposures
- Exposure and odds ratios
- Exposure institutions, societies, journals, and data bases

UNITS OF MEASUREMENT – Week 1

- Air as an ideal gas
- Concentration units for gases
- Concentration units for particles
- Exposure units (+ unit risk factors; exposure limits)
- Dose units (+ potency factors)

MASS BALANCE MODELS – Week 2

- Basic mass balance model for a well-mixed indoor environment
- Source and sink terms
- Key parameters
- Steady-state solution
- Dynamic solution
- Microenvironment (near field) effects on exposure

POPULATION EXPOSURE ANALYSIS – Week 3

- Model foundation
- Human activity patterns

HUMAN RESPIRATORY SYSTEM – Week 3/ 4

- Major regions and features
- Inhalation parameters (respiratory rates and volumes; inhaled air composition)
- Exhalation parameters (exhaled air composition; water vapor; carbon dioxide)
- Pollutant fate in the respiratory system (overview)

INTAKE FRACTION – Week 4

- Basic concept
- Comparison of source contributions to exposure
- Applications to indoor sources (steady-state and dynamic)
- Comparison with outdoor sources

PARTICULATE MATTER – Week 5/6

- Sources
- Important characteristics
- Deposition to indoor surfaces
- Exposure, uptake and respiratory deposition
- Respiratory effects
- Engineering solutions to reduce exposure

AIRBORNE INFECTIOUS DISEASE TRANSMISSION – Week 6/7

- Infectious diseases
- Wells-Riley equation
- Milton-Rudnick model
- Model parameters: Re-breathed fraction, reproductive number, critical re-breathed fraction, etc.
- Applications and engineering implications

CARBON MONOXIDE – Week 7

- Sources and mechanism of formation
- Uptake and fate in the body
- Exposure to carbon monoxide and associated effects

RADON – Week 8

- Ionizing radiation
- Radon and its sources
- U-238 decay chain
- Radioactivity and its units
- Distribution, levels, and health risks in the United States/Texas
- Soil vapor transport and intrusion (simple model)
- Volatilization from water
- Engineering solutions to reduce exposure

OZONE – Week 10

- Ozone formation and levels outdoors
- Sources of indoor ozone
- Ozone reactions with indoor surfaces
- Indoor ozone concentrations (and outdoor/indoor ratios)
- Exposure to ozone and associated effects
- Engineering solutions to reduce exposure

VOCs & CARBONYLS – Week 11/12

- General definitions and classifications
- Some important indoor VOCs, carbonyls and their sources
- Exposure in indoor environments (including effects of adsorption)
- Some examples (sources, fate, exposures, health effects)
    - BTEX
    - *p*-Dichlorobenzene and naphthalene
    - Texanol ester alcohol
    - Cleaning chemicals (2-butoxyethanol, etc.)
    - Microbial VOCs (MVOCs)
    - Formaldehyde
    - Terpenes
    - Ozone reaction products
- Engineering solutions to reduce exposures

SVOCs – Week 13

- General definitions
- Exposure in indoor environments (general – including partitioning to particles and materials)
- Some examples (sources, fate, exposures, health effects)
    - Phthalates (sources, fate, exposure, health effects)
    - Brominated flame retardants
    - Methamphetamine
- Engineering solutions to reduce exposures

PHARMACOKINETIC MODELING – Week 14/15

- Blood-air partitioning
- Regions and blood flow
- Compartmental partitioning
- Biotransformation
- Five-compartment model

CLOSURE: THE FUTURE OF EXPOSURE SCIENCE – Week 16

- Source summary
- Major issues that should and will be addressed in the next decade