Lectures: Mon., Wed., and Fri., 1:25-2:15 p.m., Room 124 Walker Building
Prerequisite: At least one undergraduate fluid mechanics course.
Web Pages: The main website for this course is [www.me.psu.edu/cimbala/me405](http://www.me.psu.edu/cimbala/me405). Sensitive material (e.g., grades) are posted on Canvas at [canvas.psu.edu](http://canvas.psu.edu). Students are expected to check the websites regularly for homework assignments and other information. Hardcopies (handouts) of class material will not be given in class.
Instructor: John M. Cimbala, Professor of Mechanical Engineering. 234 Reber Building, 814-863-2739, jmc6@psu.edu, [www.me.psu.edu/cimbala](http://www.me.psu.edu/cimbala). Office hours and weekly schedule posted on website.
TA/Grader: Xi Chen, xbc5027@psu.edu [See TA link on the course website for TA office hours.]

**General Description and Course Outline:**
This course is a technical elective for seniors and graduate students. It provides an introduction to environmental health and indoor air quality engineering. The first topics include the fundamentals of risk, air mixtures, and air pollution concentration. Then models and diseases of the respiratory system are discussed and analyzed. Issues of indoor air quality other than air pollution, such as fire and explosion, noise, heat, and odors are also discussed. Emission factors are introduced along with methods of estimating particle removal systems (air pollution control systems, or APCSs).

**Course Objectives:** Upon completion of this course, students should be able to:
1. Demonstrate an ability to analyze and compare risks associated with various activities and exposure to hazardous chemicals.
2. Demonstrate a working knowledge of the physiology and function of the respiratory system, including diseases of the lung.
3. Demonstrate an ability to estimate pollutant emission rates using emission factors and fundamental mass balance techniques.
4. Analyze practical problems that involve building, room, and tunnel ventilation requirements and systems.
5. Design local ventilation systems using standard guidelines from ACGIH and ASHRAE.
6. Predict the motion of particles in air, and analyze pollution control devices that remove particles from the air.
7. Demonstrate professionalism and respectful interaction with faculty and colleagues.

**Lecture Schedule:** A more detailed week-by-week breakdown is provided on the course website.

<table>
<thead>
<tr>
<th>Week #</th>
<th>Topics to be Covered [Note: We will follow this schedule as closely as possible, subject to change]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction: risk, concentrations of air pollutants, fundamentals of contaminant mixtures</td>
</tr>
<tr>
<td>2</td>
<td>The respiratory system: anatomy of the lungs, modeling gas exchange, diseases; body burden; 1st-order systems</td>
</tr>
<tr>
<td>3-4</td>
<td>Design criteria: contaminant concentration limits, fire and explosion, hearing and sound, heat stress, odors</td>
</tr>
<tr>
<td>5</td>
<td>Pollutant emission rates: physical measurements, flux chambers, mass balances, emission factors; Diffusion</td>
</tr>
<tr>
<td>6</td>
<td>Evaporation: evaporation from liquid surfaces, evaporation in confined spaces, thermodynamics of evaporation</td>
</tr>
<tr>
<td>7-9</td>
<td>General ventilation: the well-mixed model: dilution vs. displacement ventilation, sources, wall losses, recirculation, air cleaners, infiltration and exfiltration, various room configurations, clean rooms, effectiveness of ventilation systems, heating and cooling costs, ventilation in tunnels</td>
</tr>
<tr>
<td>10-11</td>
<td>Local ventilation: hood design, bulk materials, proper selection and design of hoods, buoyant plumes, canopy hoods, air curtains, air cleaners in series and parallel</td>
</tr>
<tr>
<td>12</td>
<td>Exhaust duct system design: energy equation, major and minor losses, fan performance curves, fan selection (matching fan to duct system requirements)</td>
</tr>
<tr>
<td>13</td>
<td>Particulate air pollution: particle sizes/classifications/terminology, aerodynamic drag and drag coefficient, particles settling in quiescent air (gravimetric settling - terminal settling speed); Equations of particle motion and particle trajectory calculations in an air flow, using Runge-Kutta to predict 2-D particle trajectories; Non-spherical particles - equivalent diameters; Gravimetric settling in rooms and ducts; Inertial separation in curved ducts</td>
</tr>
<tr>
<td>14-15</td>
<td>Air pollution control devices (APCSs): Lapple cyclones, performance and efficiency of APCSs, series and parallel APCSs for particle removal, filters; Review for final exam</td>
</tr>
</tbody>
</table>

**Grading:** All exams and homework assignments are comprehensive. Mark your calendars!

| Homework | 20% | Approximately one per week except during exam weeks – expect 10 total – see website |
| Exam 1    | 25% | In class, Friday October 4 |
| Exam 2    | 25% | In class, Friday November 8 |
| Final Exam | 30% | Monday, 12/16/2019, 10:10AM - noon, 5 Health and Hum Dev |

(Continued on next page →)
Grade Disputes: If a student feels that an exam or homework set was graded unfairly, or if there is an error in the grading, it should be brought to the attention of the grader (HW→TA, Exams→instructor) within one week after the graded material is handed back. Scores will not be reconsidered beyond one week after they are handed back, except under unusual circumstances.

Cheating Policy: Cheating is not tolerated in this course. You should refer to the Academic Integrity website at http://www.engr.psu.edu/faculty-staff/academic-integrity.aspx which explains what behaviors are in violation of academic integrity, and the review process for such violations. On the next page is a summary of the policy. Specifically for this course:

- First offense: Zero score for the item in question, and infraction reported to the College.
- Second offense: Failure of the course, and infraction reported to the College.

Academic Integrity Definition and Expectations: Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle.

Summary of Penn State’s Academic Dishonesty Policy: The University defines academic integrity as the pursuit of scholarly activity in an open, honest and responsible manner. All students should act with personal integrity, respect other students’ dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts (refer to Senate Policy 49-20). Dishonesty of any kind will not be tolerated in this course. Dishonesty includes, but is not limited to, cheating, plagiarizing, fabricating information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other students. Students who are found to be dishonest will receive academic sanctions and will be reported to the University’s Office of Student Conduct for possible further disciplinary sanctions (refer to Senate Policy G-9).

Mandatory PSU Information:

Accommodating Disabilities and Disability Access Statement:
Penn State welcomes students with disabilities into the University’s educational programs. Every Penn State campus has an office for students with disabilities. The Office for Disability Services (ODS) Web site provides contact information for every Penn State campus: http://equity.psu.edu/student-disability-resources/disability-coordinator. For further information, please visit the Office for Disability Services Web site: http://equity.psu.edu/ods.
Penn State welcomes students with disabilities into the University's educational programs. Every Penn State campus has an office for students with disabilities. The Office for Disability Services Web site provides contact information for every Penn State campus: For further information, please visit the Student Disability Resources Web site: http://equity.psu.edu/student-disability-resources. In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation. See http://equity.psu.edu/student-disability-resources/applying-for-services. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. You must follow this process for every semester that you request accommodations.

Counseling & Psychological Services (CAPS) Statement:
CAPS can help students resolve personal concerns that may interfere with their academic progress, social development, and satisfaction at Penn State. Some of the more common concerns include anxiety, depression, difficulties in relationships (friends, roommates, or family); sexual identity; lack of motivation or difficulty relaxing, concentrating or studying; eating disorders; sexual assault and sexual abuse recovery; and uncertainties about personal values and beliefs. You can contact CAPS by calling the Main CAPS number/Appointment Scheduling: 814-863-0395 (Please call between the hours of 8am and 5pm, Monday-Friday to schedule an appointment) or visit us at our office location, 5th Floor Student Health Center.

Online Resources for Relaxation:
It's important to take care of yourself. There are a number of valuable online resources that you can use for relaxation and stress reduction. Learn how stress impacts your health and life, as well as some self-help strategies for managing it through the PSU Student Affairs EDGE online workshop. Check out other stress management resources available, including a guided program called Stress Recess. There are also a number of relaxation, visualization, and mindfulness resources at the Mind Body Spa. You can also download mindfulness meditations here. If winter has got you down and you need an upbeat song to listen to, check this out.

Sexual Assault and Relationship Violence Hotline:
A hotline has been established for victims and observers of sexual assault and relationship violence. Trained counselors on the hotline will help students access appropriate resources. Penn State students from any campus can call 1 (800) 560-1637 to access the 24 hour a day, seven day a week hotline.

(Continued on next page →)
**Library Resources:**
Many of Penn State's library resources can be utilized from a distance. Through the University Libraries website, you can
- access magazine, journal, and newspaper articles online using library databases;
- borrow materials and have them delivered to your doorstep...or even your desktop;
- get research help via e-mail, chat, or phone using the Ask a Librarian service [Link to external site]; and much more.
You must have an active Penn State Access Account to take full advantage of the University Libraries' resources and services. Once you have a Penn State account, you will automatically be registered with the library within 24–48 hours. If you would like to check that your registration has been completed, visit the Libraries home page [Link to external site] and then click on Library Accounts, and then click on My Library Account.

**Grading Scale:**
The following are minimum cutoffs for each grade:
- 90.00% = A
- 86.66% = A-
- 83.33% = B+
- 80.00% = B
- 76.66% = B-
- 73.33% = C+
- 70.00% = C
- 60.00% = D
- less than 60.00% = F

**Academic Integrity:**
Academic integrity—scholarship free of fraud and deception—is an important educational objective of Penn State. Academic dishonesty can lead to a failing grade or referral to the Office of Student Conduct [Link to external site]. Academic dishonesty includes but is not limited to
- cheating,
- plagiarism,
- fabrication of information or citations,
- facilitating acts of academic dishonesty by others,
- unauthorized prior possession of examinations,
- submitting the work of another person or work previously used without informing the instructor and securing written approval, and
- tampering with the academic work of other students.

The University defines academic integrity as the pursuit of scholarly activity in an open, honest and responsible manner. All students should act with personal integrity, respect other students’ dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts (refer to Senate Policy 49-20). Dishonesty of any kind will not be tolerated in this course. Dishonesty includes, but is not limited to, cheating, plagiarizing, fabricating information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other students. Students who are found to be dishonest will receive academic sanctions and will be reported to the University’s Office of Student Conduct for possible further disciplinary sanctions (refer to Senate Policy G-9).

**How Academic Integrity Violations Are Handled:**
In cases where academic integrity is questioned, the Policy on Academic Integrity [Link to external site] indicates that procedure requires an instructor to notify a student of suspected dishonesty before filing a charge and recommended sanction with the college. Procedures allow a student to accept or contest a charge. If a student chooses to contest a charge, the case will then be managed by the respective college or campus Academic Integrity Committee. If a disciplinary sanction also is recommended, the case will be referred to the Office of Student Conduct [Link to external site]. All Penn State colleges abide by this Penn State policy, but review procedures may vary by college when academic dishonesty is suspected. Information about Penn State's academic integrity policy and college review procedures is included in the information that students receive upon enrolling in a course. To obtain that information in advance of enrolling in a course, please contact us by going to the Contacts & Help page [Link to external site].

Additionally, World Campus students are expected to act with civility and personal integrity; respect other students' dignity, rights, and property; and help create and maintain an environment in which all can succeed through the fruits of their own efforts. An environment of academic integrity is requisite to respect for oneself and others, as well as a civil community.

**For More Information on Academic Integrity at Penn State:**
Please see the Academic Integrity Chart [Link to external site] for specific college contact information or visit one of the following sites:
- Penn State Senate Policy on Academic Integrity [Link to external site]
- iStudy for Success! [Link to external site], (education module about plagiarism, copyright, and academic integrity)
- Turnitin [Link to external site] (a web-based plagiarism detection and prevention system)