

# Chemical and Biological Engineering 485

## Air Pollution Prevention and Control

**Instructor:** Anthony Lau      Email: [anthony.lau@ubc.ca](mailto:anthony.lau@ubc.ca)      Office: CHBE 247  
Office hours: Mon 3-5 pm

**Lectures:** Mon Wed Fri      12-1 pm      PHRM 1201  
**Tutorials:** Wed      2-4 pm      CHBE 101  
Sep 7, Sep 21, **Oct 5**, Oct 19, **Nov 16**

**TA:** Kanages Singaraveloo      Email: [kanages3@mail.ubc.ca](mailto:kanages3@mail.ubc.ca)  
Sofia Lucero Saucedo      Email: [sofia240@mail.ubc.ca](mailto:sofia240@mail.ubc.ca)

**Website:** <http://canvas.ubc.ca>

**Course notes:** Lecture notes and reference materials will be provided through Canvas.

### Optional textbooks:

Cooper, C.D. and F.C. Alley. 2011. Air pollution control: A design approach, 4th edition, Waveland Press Inc., Prospect Heights, IL

Sternberg, S.P.K. 2015. Air pollution: engineering, science, and policy, College Publishing, Glen Allen, VA (eBook: <http://www.vitalsource.com>)

### Learning Outcomes

Upon successful completion of this course, students should be able to:

- Identify different categories and sources of air pollutants and explain their impact on human health, welfare, and the environment
- Develop a conceptual understanding of pollution control vs. pollution prevention technologies, and discuss measures for air pollution prevention
- Gain a basic understanding of the legal requirements for air pollution control
- Use the mass balance and the emission factor methods to estimate source emissions
- Apply atmospheric dispersion modeling for predicting the concentrations of pollutants downwind from the source and their impact on ambient air quality
- Describe, discuss, and analyze the physical/thermal, chemical and biological technologies that are used for the control of air pollution emissions from different sources
- Demonstrate the ability to organize and communicate their ideas in written form

### Course Content

#### Chapter 1. Introduction to air pollution control and prevention (Weeks 1-2)

1.1 Definition and categories of air pollutants

1.2 Sources and causes of air pollution

1.3 Air pollution and air quality

1.4 Effects of air pollution on human health and the environment

1.5 Examples of air pollution control and pollution prevention technologies

## **Chapter 2. Air pollution regulations and estimation of emissions (Weeks 2-4)**

- 2.1 Ambient air quality criteria and standards
- 2.2 Source emission standards
- 2.3 Air pollutants audit and inventories

## **Chapter 3. Dispersion of pollutants in the atmosphere (Weeks 4-6)**

- 3.1 Atmospheric stability classes and plume profiles
- 3.2 Atmospheric dispersion modeling – gaseous pollutants and particulates
- 3.3 Dispersion modeling systems - screening models and refined models

## **Chapter 4. Prevention and control of particulate matter (Weeks 7-9)**

- 4.1 Characteristics and particle distribution
- 4.2 Collection mechanisms
- 4.3 Control equipment - theory and design considerations

## **Chapter 5. Prevention and control of gaseous pollutants (Weeks 10-12)**

Control equipment – theory and design considerations for:

- 5.1 Nitrogen oxides
- 5.2 Sulfur oxides
- 5.3 Volatile organic compounds and Odours
- 5.4 Greenhouse gases (carbon dioxide and methane)

## **Summary (Week 13)**

### **Assessment**

Assignments	25%
Homework assignments (4)	
Tutorial assignments (2)	
Midterm Exam ( <b>Nov 2, in-person</b> , open book)	35%
Term Paper	40%

#### Assignment submission deadlines:

- Homework assignments are to be submitted via Canvas on the due dates.
- Tutorial assignments are to be submitted via Canvas two days after each of the following tutorial sessions: **Oct 5, Nov 16**
- Late assignments: 10% of the maximum possible mark will be deducted per day. Assignments submitted after the solutions have been posted will not be marked.

### **STUDENT RESOURCES**

UBC is committed to a community in which every member is respected, included, and celebrated. Taking care of your health and wellbeing is important. UBC Health & Wellness is here to support wellness of mind, body, and spirit, and provides a range of clinical, counselling, and mental health services for students.

<https://senate.ubc.ca/policies-resources-support-student-success/>

<https://students.ubc.ca/health>

**Academic Advising** empowers students to take ownership of their education at UBC by offering personalized advising services in a supportive environment.

- For CHBE-specific issues such as CHBE course registration and planning, you can connect with CHBE Departmental staff.  
<https://chbe.ubc.ca/undergraduate/advising/>  
Drop-in meetings with and advising by CHBE staff is available through Zoom. Staff is available Monday to Friday from 9:00 am to 3:30 pm. You may also email your questions or requests for appointments to [undergrad@chbe.ubc.ca](mailto:undergrad@chbe.ubc.ca).
- For issues beyond CHBE, such as academic concession, late withdrawals, SD exams, and letters of permission/completion, you can reach out to Engineering Academic Services.  
<https://academicervices.engineering.ubc.ca/>

**First Nations Longhouse:** The First Nations Longhouse serves as a “home away from home,” as well as an academic, social, spiritual, and cultural hub for Indigenous students attending UBC.  
<https://indigenous.ubc.ca/longhouse/>

**International Student Advising** provides advising and resources to assist international students in navigating immigration, health insurance, and settlement matters.  
<https://students.ubc.ca/about-student-services/international-student-advising>

The **Centre for Accessibility** facilitates disability-related accommodations and programming initiatives designed to remove barriers for students with disabilities and ongoing medical conditions in all aspects of university life. If you think you may need academic accommodations to meet the learning outcomes of this course and you have a disability, please contact the Centre for Accessibility. <https://students.ubc.ca/about-student-services/centre-for-accessibility>

### **COVID-19 and UBC’s response**

<https://covid19.ubc.ca/information-for-students/>

UBC is conducting in-person classes. The health, safety and wellbeing of our students, faculty and staff remain our first priority. Here’s what you need to do to help ensure a safe environment for yourself and those around you:

- Know the symptoms of COVID-19 and complete a daily health assessment. If you are sick, stay at home.
- Wash your hands regularly.
- Follow the measures outlined in the COVID-19 Campus Rules. You can learn more at <https://srs.ubc.ca/covid-19/ubc-campus-rules-guidance-documents/>
- We strongly recommend that all UBC community members get vaccinated and if eligible, receive their booster dose, which minimizes the severity of illness and transmission to others. In BC, free vaccines are available to students arriving from international destinations and other provinces. You can learn more at <https://immunizebc.ca>.

## **CHBE 485 Term Paper Guidelines (2-3 students per group)**

**Due: December 9, 2022**

The purpose of the term paper is to perform literature review on a topic relevant to air pollution control and/or air pollution prevention.

- An essay of **2,500-3,000 words PLUS illustrations (tables; figures) and references** for 2-member groups
- An essay of **4,000-4,500 words PLUS illustrations (tables; figures) and references** for 3-member groups
  
- Cite a minimum of 6 refereed journal papers
- At least 50% of the contents must be allocated to the analysis and discussion of applicable air pollution control and/or air pollution prevention technologies
- Evaluation of the paper will be based on technical contents (75%), and organization/presentation (25%)

To achieve “A” grade for the paper, you shall demonstrate the following:

- Generally well-organized with an appropriate structure
- High degree of engagement with the topic
- Excellent comprehension of subject and use of existing literature and research
- Attempts at critical analysis and original argument,
- Appropriate use of **illustrative examples and data** to support the discussion and analysis

You shall identify an air pollution problem that is relevant to a particular industry, community, region, or a global issue. The contents of the paper shall include the following:

- An account of air emissions from the sources and/or ambient air quality
- Impacts on human health, welfare, and the environment
- Air pollution control technologies and their effectiveness, **and/or** Air pollution prevention technologies and their effectiveness
- Calculations where applicable (shown in the Appendix)
- (optional) Regulations
- (optional) Monitoring techniques
- (optional) Dispersion modeling

### **Paper:**

Please submit an electronic copy of your term paper via the course website (<http://canvas.ubc.ca>) by the due date.

## Relevant journals (examples)

- Aerosol Science and Technology
- Atmospheric Environment
- Environmental Pollution
- Environmental Science and Technology
- Global Biogeochemical Cycles
- International Journal of Greenhouse Gas Control
- Journal of Air & Waste Management Association
- Journal of Environmental Management
- PLoS One
- Science of The Total Environment
  
- Energy Policy
- Environmental Health Perspectives
- Journal of Cleaner Production
- Journal of Hazardous Materials
- Renewable and Sustainable Energy Reviews

## Reference books

- Bakshi, B.R. 2019. Sustainable engineering – principles and practice. Cambridge University Press, UK.
- Vallero, D. 2014. Fundamentals of air pollution, 5th edition, Elsevier, Boston, MA (UBC eBook)
- Veiga, M.C. and C. Kennes (eds.) 2013. Air pollution prevention and control : Bioreactors and bioenergy. John Wiley & Sons Inc., New York. (UBC eBook)
- Kreith, F. and J.F. Kreider. 2011. Principles of Sustainable Energy. CRC Press. Boca Raton, FL.
- Heck, R.M., R.J. Farrauto and S.T. Gulati. 2009. Catalytic air pollution control – commercial technology. John Wiley & Sons Inc., Hoboken, NJ (UBC eBook)
- Shareefdeen, Z. and A. Singh (eds.) 2005. Biotechnology for odor and air pollution control. Springer-Verlag, Berlin. (UBC eBook)
- Marsh, W.M. and J. Grossa, Jr. 2002. Environmental geography – science, land use, and earth systems. John Wiley & Sons Inc., New York.
- Cheremisinoff, N.P. (ed.) 2002. Handbook of air pollution prevention and control. Butterworth-Heinemann, Amsterdam. (UBC eBook)
- Schiffner, K.C. (ed.) 2002. Air pollution control equipment selection guide. Lewis Publishers, Boca Raton, FL. (UBC eBook)
- De Nevers, N. 2000. Air pollution control engineering, 2nd edition, McGraw Hill, New York.
- Wark, K. C.F. Warner and W.T. Davis. 1998. Air Pollution: its origin and control, 3rd edition, Prentice Hall, NJ