

Carleton University
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

ENVE5103 Air Quality Modelling - COURSE OUTLINE

The objective of this course is to provide an overview of and experience with dispersion and receptor model models that are used to quantify the impacts of point, line, and area sources of conservative pollutants on air quality at the local and regional scales. Previous editions of the course have included material on atmospheric chemical transport modelling as well. Students interested in this topic can now find an in-depth treatment in ENVE5106 Atmospheric Chemical Transport Modelling offered by Prof. A. Hakami.

Learning outcomes:

Students passing the course are expected to:

- Understand the sources and effects of different air pollutants.
- Understand the atmospheric phenomenon governing the transport of air pollutants from sources to receptors.
- Be aware of the regulatory framework governing emissions of air pollutants from different sources.
- Be able to use appropriate models for quantifying the environmental impacts of air pollutant emissions from different sources.

Content by weeks (approximate)

Week	Subjects
Introduction	
1	Overview of air pollution phenomena. Modelling approaches and their role in air quality management.
Part I: Dispersion Modelling	
2-3	Atmospheric structure and circulations, wind velocity profile, lapse rate and stability, mixing height, Gaussian dispersion models. Simple screening models (SCREEN)
4-5	Plume rise, stack tip downwash, building wake effect, terrain complications in dispersion modelling. The industrial source complex (ISC) model and AERMOD.
6-8	The special cases of line sources and time varying emissions and meteorology in complex terrain. The CALINE, CAL3QHC and CALPUFF models.
Part II: Receptor Modelling	
9-12	Source apportionment with receptor models for atmospheric particulate matter and organic compounds at the local and regional scale. CMB and PMF models.

References

1. Wark, K., Warner, C.F., Davis, W.T., *Air Pollution - its origin and control*, 3rd ed. Addison & Wesley, 1998. (Chapter 3. Meteorology, Chapter 4. Dispersion of Pollutants in the Atmosphere)
2. de Nevers, N., *Air Pollution Control Engineering*, McGraw-Hill, 1995. (Chapter 5. Meteorology for Air Pollution Control Engineers, Chapter 6. Air Pollution Concentration

- Models)
3. Seinfeld, J.H., Pandis, S.N., *Atmospheric Chemistry and Physics*, Wiley-Interscience, 1998. (Chapter 1. The Atmosphere, Chapter 14. Meteorology of Air Pollution , Chapter 16. Micrometeorology)
 4. Turner, D.B., *Workbook of Atmospheric Dispersion Estimates: an introduction to dispersion modelling*, 2nd Ed., Lewis Publishers - CRC Press, 1994.
 5. Heinsohn, R.J., Kabel, R.L., *Sources and Control of Air Pollution*, Prentice-Hall, 1999. (Chapter 9. Atmospheric Dispersion)
 6. Wallace, J.M., Hobbs, P.V., *Atmospheric Science: An Introductory Survey*, 2nd ed. , Elsevier, 2006.(Chapter 7. Atmospheric Dynamics, Chapter 9. The Atmospheric Boundary Layer)
 7. Air Dispersion Modelling Guideline for Ontario, Version 2.0, Ontario Ministry of the Environment, March 2009. Available at:
<http://www.ontario.ca/document/guideline-11-air-dispersion-modelling-guideline-ontario>
 8. Guideline for the Implementation of Air Standards in Ontario, Version 2.0, Ontario Ministry of the Environment, March 2009. (Available at:
<http://www.ontario.ca/document/guideline-implementation-air-standards-ontario>

Journals

Atmospheric Environment is the primary journal for papers of interest to this course. Specific references from it and others will be quoted each week in connection with the course material.

Web sites

9. Environment Canada, Air Pollution Issues, Sources, Impacts, Action.
<http://www.ec.gc.ca/Air/default.asp?lang=En&n=14F71451-1>
10. Ontario Ministry of the Environment, Air Quality in Ontario
<http://www.airqualityontario.com/>
11. U.S. EPA, Support Center for Regulatory Air Models (SCRAM)
<http://www.epa.gov/ttn/scram/>
The SCRAM website is probably the most comprehensive source of models, manuals, and regulations concerning air quality models. The website is maintained by the U.S. Environmental Protection Agency in support of regulatory programs required by the U.S. Clean Air Act. Source code, documentation and guidance for computer models that can be downloaded in *.zip, *.exe, *.doc, *.pdf formats are a major feature of this website.
12. World Health Organization – Air Pollution
http://www.who.int/topics/air_pollution/en/
13. International Agency for Research on Cancer
http://www.who.int/ionizing_radiation/research/iarc/en/

A number of engineering/software companies have developed user friendly (and commercial) versions of the regulatory models and documentation that are available free of charge from the SCRAM web site. These software packages incorporate the same physical principles (and in fact the same computational codes) but offer a number of convenient input/output/productivity features for professionals. For example, see the following web sites:

14. Lakes Environmental
<http://www.lakes-environmental.com/>
15. Scientific Software Group
http://www.scisoftware.com/environmental_software/index.php?cPath=25
16. Trinity Consultants
<http://www.breeze-software.com/>

Evaluation of Students' Work:

- 40 % Assignments
- 20 % 1 mid-term examination
- 40 % Final Examination

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ACADEMIC ACCOMODATION

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website:

<http://www.carleton.ca/equity/>

Religious obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website:

<http://www.carleton.ca/equity/>

Academic Accommodations for Students with Disabilities: The **Paul Menton Centre** for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your **Letter of Accommodation** at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (*if applicable*). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (*if applicable*) at <http://www.carleton.ca/pmc/new-and-current-students/dates-and-deadlines/>

You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at <http://www.carleton.ca/equity/>