# CHEM 3060/ESSE 3130 – Introduction to Atmospheric Chemistry
# Fall 2023

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**Professor**: Dr. Trevor VandenBoer
**Email**: profvdb@yorku.ca
**Lecture**: HNE 030 M/W/F 1:30-2:30
**Office hours**: CB344, Zoom, Friday 10-11 (or by appointment)

**Prerequisites**: Both CHEM 1000 and CHEM 1001; one of MATH 1010, MATH 1014, MATH 1310, or MATH 1505.

Other Course Information

- Lectures will be delivered in-person and audio only will be recorded using Zoom (unless otherwise indicated). These recordings will only be available to students enrolled in the course.
- Students are strongly encouraged to attend and participate in discussions during class. If you do not attend, understand that there is no guarantee of a recording.
- Office hours will be conducted through Zoom (link below). Students will require their YU Passport login and are encouraged to turn on their camera during office hours.
- Office hour:
https://yorku.zoom.us/j/99033060266?pwd=ZzliQnN2OXJoa2hqd2hoclZQZE5kUT09

Guidance for Course Success

- Review the lecture notes and rework the concepts and problems therein.
- Complete homework and practice problems on an ongoing basis (no credit for these) and ensure you can do these independently. Review any posted homework solutions.
- Visit the relevant chapters in the Recommended References (try their practice problems).
- Prepare in advance for, and write, all three tests.
- Attend lectures, participate, and make the most of office hours.

| Structure of Course Evaluation | Marks |
|---|---|
| Tests (10 each; or best 2 of 3) | 30 |
| Frontiers in Atmos Chem Seminar Series (FACSS; 3 each; 5 of 8) | 15 |
| Term paper | 20 |
| Final exam (minimum) | 35 |
| Total: | 100 |

Dates for Course Evaluations
*please note that all dates are tentative*

| | |
|---|---|
| Wednesday, October 4, 2023 | Test #1 |
| Wednesday, November 1, 2023 | Term Paper |
| Wednesday, November 8, 2023 | Test #2 |
| Friday, December 1, 2023 | Test #3 |

Evaluation Details

The grading scheme for the course conforms to the 9-point grading system used in undergraduate programs at York (e.g., A+ = 9, A = 8, B+ - 7, C+ = 5, etc.). For more information, please see the Senate Policy on Common Grading Scheme for Undergraduate Faculties (https://secretariat-policies.info.yorku.ca/policies/common-grading-scheme-for-undergraduate-faculties/).

*Tests*

- Tests will only be offered in class, on campus.
- All tests are nominally worth 10%. However, for your final test mark to be based upon best 2 of 3 scores (for 30%, i.e. 15% each) only if you write and pass all 3 tests.
- For missed tests, no doctors notes are required, and there will be no make-ups. The missed proportion will simply be applied to your final exam weighting.

*FACSS Seminars (Fridays; 1-2 pm Eastern; Recordings from Zoom)*

- This seminar series is composed of eminent and emerging researchers from around the world, who will discuss their research findings in modern atmospheric chemistry.
- Recordings from each seminar will be available for exactly one week following each presentation. They cannot be downloaded.
- You will answer questions based on the presentation recording and an associated peer-reviewed journal article (available at: https://facss.mit.edu/).
- Questions must be completed for at least 5 of the 8 presentations listed below and will be graded for correctness.

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| September 8, 2023 | Prof. Sergey Nizkorodov (U California at Irvine) |
| September 29, 2023 | Prof. Jennifer Faust (College of Wooster) |
| October 13, 2023 | Prof. Ilona Riipinen (Stockholm U) |
| October 27, 2023 | Prof. Sam Silva (U Southern Carolina) |
| November 3, 2023 | Prof. Jose Jimenez (U Colorado at Boulder) |
| November 17, 2023 | Prof. Alfonso Saiz-Lopez (IQFR-CSIC) |
| December 1, 2023 | Prof. Jen Kaiser (Georgia Tech) |

*Term Paper*

- You will identify one course-related journal article from the peer-reviewed atmospheric chemistry literature, read it, and present a short 3-page synthesis of the work in your own words.
- Journal articles must be selected from the current publication year (i.e. 2022-23) and submitted for approval by the course director (an online form will be made available).
- Term paper is due at 1:30 pm on the date indicated. Late work will be accepted with a penalty of 10 % for work received after class on the due date and an additional 10 % per calendar day to a maximum of 3 days (after which a grade of 0% will be assigned).

Recommended References

1. Holloway and Wayne. Atmospheric Chemistry, RSC Publishing 2010.
2. Jacob. Introduction to Atmospheric Chemistry, 1st or 2nd Ed. (free online) https://acmg.seas.harvard.edu/education/introduction-atmospheric-chemistry

Other Course Information (also see Appendix B, posted on eClass)

*Email Etiquette*

- Students must use their YorkU email address.
- Emails must include the course code in the subject line.
- Use professional language in emails, including a salutation and a signature that includes your full name and student number.

*Awareness*

Students must make themselves aware of York University policies on Academic Honesty/Integrity, Access/Disability, Student Conduct, Religious Observance and other matters. A periodically updated Information Sheet summarizing this information can be downloaded* and printed, as well as the Registrar's Office issues a list of Religious Observance Days.‡

* http://secretariat.info.yorku.ca/files/CourseInformationForStudentsAugust20121.pdf
‡ http://registrar.yorku.ca/enrol/dates/religious-accommodation-guidelines-2018-2019

*Accessibility and Religious Accommodations*

- Students registered with Accessibility Services must submit accommodation letters via email to Dr. VandenBoer by September 30, 2023.
- Any religious observance conflicts occurring at any point during the term should be communicated by email to Dr. VandenBoer by September 30, 2023.
    - https://www.yorku.ca/secretariat/policies/policies/academic-accommodation-for-students-religious-observances-policy-guidelines-and-procedures/
- Note: "Senate policy states that students are expected to monitor their progress in courses, taking into account their personal and academic circumstances, and to make the necessary adjustments to their workload to meet the requirements and deadlines." (from Senate Policy of Students' Responsibilities in the Petition/Appeal Processes). The drop deadline is November 8, 2023.

*Academic Honesty*

- Any student who breaches York's Academic Honesty Policy will be reported. Some offences include:
    - Plagiarism.
    - Students who misrepresent themselves during iClicker activity, a quiz, or examination or provide documentation for absence from any of these that is not legitimate.
    - Students who submit any material for remarking that has been modified in any manner to misrepresent the original assessment.
- Information regarding the consequences for academic dishonesty at York University can be found in the “Academic dishonesty consequences” document on eClass.
- Students are strongly encouraged to familiarize themselves with these policies. Ignorance of the policies is not an acceptable excuse. https://spark.library.yorku.ca/academic-integrity-what-is-academic-integrity/

## Course Learning Objectives

Develop a comprehensive view of the principles of atmospheric chemistry, enabling students to:

i. Describe and calculate how the distribution, sources, and fate of chemicals in the atmosphere arise through reaction kinetics or physical transport.
ii. Communicate the relevant chemistry of the stratosphere and troposphere towards solving global issues like ozone depletion and air pollution.
iii. Gain the ability to describe the global movement of elements where the atmosphere plays a substantial role.
iv. Depict the atmospheric radiative balance and chemical drivers of global climate.

## Course Content Overview

| Unit | Topic and Components |
|---|---|
| **1** | **Basic Concepts** |
| | - Units used in atmospheric chemistry<br>- Composition and mass of the atmosphere<br>- Vertical temperature structure of the atmosphere<br>- The barometric law and uniformity of atmospheric constituents |
| **2** | **Mass balance, steady state, and atmospheric change** |
| | - Review of chemical kinetics<br>- Mass balance, steady state, atmospheric lifetime of chemical reactions<br>- Sources of atmospheric components<br>- Sinks of atmospheric components<br>- Mass balance and simple models<br>- Transport in simple atmospheric models<br>- Atmospheric mixing |
| **3** | **Biogeochemical Cycles** |
| | - The carbon cycle<br>- The oxygen cycle<br>- Coupling between the carbon and oxygen cycles<br>- The nitrogen and sulphur cycles |
| **4** | **Stratospheric Chemistry** |
| | - Basics of photochemical processes<br>- Pressure dependence of reaction rates<br>- The ozone layer and Chapman mechanism<br>- Basics of stratospheric chemistry<br>- Catalytic cycles for ozone destruction<br>- The Antarctic ozone hole |

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| **5** | **Tropospheric Chemistry** |
| | - Sources and reactions of free radicals<br>- Chain oxidation of hydrocarbons, production of ozone<br>- Comparison of stratospheric and tropospheric ozone chemistry<br>- Chain termination reactions<br>- Formation of photochemical smog<br>- Acid deposition |
| **6** | **Radiative Forcing, Greenhouse Effect, and Climate Change** |
| | - Absorption and emission of radiation<br>- Radiative balance of the Earth<br>- Modelling of the greenhouse effect<br>- Climate change |
| **7** | **Aerosols and Particles (time permitting)** |