# ENGG*4810 Control of Atmospheric Particulates

Fall 2017

Sections(s): C01

School of Engineering

Credit Weight: 0.50

Version 1.00 - September 05, 2017

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# 1 Course Details

## 1.1 Calendar Description

The focus of this course is understanding, analyzing and designing conventional and innovative atmospheric particulate control systems. The properties and transport of atmospheric particulates, and the principles of cyclones, filtration and electrostatic precipitation will be taught through theory, simulations, experiments and a design project.

**Pre-Requisite(s):** 6.00 credits of ENGG courses, ENGG*2230, ENGG*2450, MATH*2130

**Restriction(s):** ENGG*4330

## 1.2 Course Description

The focus of this course is understanding, analyzing and designing conventional and innovative atmospheric particulate control systems. The properties and transport of atmospheric particulates, and the principles of cyclones, filtration and electrostatic precipitation will be taught through theory, simulations, experiments and a design project.

Prerequisite(s): 6.00 credits of ENGG courses, ENGG*2230, ENGG*2450, MATH*2130

## 1.3 Timetable

Lectures:
Tue. & Thu.  01:00 pm - 02:20 pm  MINS, Room 103

Labs/Tutorials:
Mon. (Section 01)  09:30 am - 11:20 am  THRN, Room 1002, 1004, 1116
Wed. (Section 03)  11:30 am - 01:20 pm  THRN, Room 1002, 1004, 1116

## 1.4 Final Exam

There is no final exam

# 2 Instructional Support

## 2.1 Instructor(s)

**Amir Aliabadi Ph.D., P.Eng.**

Email: aaliabad@uoguelph.ca

Telephone: +1-519-824-4120 x54862

Office: RICH 2515

Office Hours: To Be Announced In Class (TBAIC)

## 2.2 Instructional Support Team

Lab Technician: Joanne Ryks

Email: jryks@uoguelph.ca

Telephone: +1-519-824-4120 x54087

Office: THRN 1114

## 2.3 Teaching Assistant(s)

| Name | Details |
|---|---|
| Mohsen Moradi | moradim@uoguelph.ca TBAIC |

# 3 Learning Resources

## 3.1 Required Resources(s)

**Course Website (Website)**

https://courselink.uoguelph.ca
Course material, news, announcements, and grades will be regularly posted to the ENGG*4810 CourseLink site. You are responsible for checking the site regularly.

**Required Resources (Other)**

Required resources will be distributed via CourseLink.

## 3.2 Recommended Resources(s)

**Fundamentals of Air Pollution Engineering (Textbook)**

Flagan, R. C. and Seinfeld, J. H. 2012. Courier Corporation, Dover Publications, U.S.A. (primary reference, available in bookstore).

**Atmospheric Chemistry and Physics: from Air Pollution to Climate Change (Textbook)**

Seinfeld, J. H. and Pandis, S. N. 2016. 3rd Ed. John Wiley & Sons Inc., Hoboken, New Jersey,

U.S.A. (support reference, available in bookstore).

## 3.3 Additional Resources(s)

**Lecture Information (Notes)**

Lecture notes and supporting material will be posted on CourseLink, generally before the speci c lecture. Note that posted notes may be incomplete, prepared with the intention that students will take additional notes during lectures.

**Experimental Lab Information (Other)**

Lab manuals and report speci cations will be posted on CourseLink.

**Computer Lab Information (Other)**

Lab manuals will be posted on CourseLink

**Project Information (Other)**

Project requirements will be posted on CourseLink.

**Problem Sets (Other)**

Problems will be posted on CourseLink.

**Miscellaneous Information (Other)**

Other information will be posted on CourseLink.

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# 4 Learning Outcomes

The primary aim of this course is to have students learn about generation, transportation, and transformation of atmospheric particulates. We will investigate aerodynamics, thermodynamics, and interaction of atmospheric particulates. The focus is on technologies that help remove atmospheric particulates from air-particle streams including settling chambers, cyclones, electrostatic precipitators, and Filtration. A secondary aim is to understand the impact of engineering on society, economy, and the environment. The primary aim will be pursued through analytical, experimental, and numerical investigations, while the secondary aim is pursed by an essay project.

## 4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. **Analyze** aerodynamic, thermodynamic, and interaction of atmospheric particulates.
2. **Analyze** air-particle systems using analytical skills.
3. **Develop** computer-based models to analyze physics and chemistry of air-particle systems.
4. **Critique** various particle control technologies..
5. **Create** ideas for incremental innovations within particulate control technologies.
6. **Design** a particulate control device using computer-based simulation.
7. **Investigate** social, economic, and environmental impacts of engineering.
8. **Communicate** learning activities in the form of reports and essays.

## 4.2 Engineers Canada - Graduate Attributes

Successfully completing this course will contribute to the following:

| # | Outcome Set Name | Course Learning Outcome |
|---|---|---|
| 1 | Knowledge base | 4 |
| 1.1 | Recall, describe and apply fundamental mathematical principles and concepts | 4 |
| 1.2 | Recall, describe and apply fundamental concepts and principles in natural sciences | 4 |
| 1.3 | Comprehend and apply fundamental engineering concepts | 4 |
| 1.4 | Comprehend and apply program-specific engineering concepts | 4 |
| 2 | Problem analysis | 3, 4 |
| 2.1 | Formulate a problem statement in engineering and nonengineering terminology | 3, 4 |
| 2.2 | Construct a conceptual framework | 3, 4 |
| 2.3 | Identify, organize and justify appropriate information | 3, 4 |
| 2.4 | Execute an engineering solution | 3, 4 |
| 2.5 | Critique and appraise results | 3, 4 |
| 3 | Investigation | 3 |
| 3.1 | Propose and test working hypotheses | 3 |
| 3.2 | Design and apply an investigation plan | 3 |
| 3.3 | Analyze and interpret experimental data | 3 |
| 3.4 | Assess validity of conclusions within limitations of data and methodologies | 3 |
| 5 | Use of engineering tools | 2 |
| 5.1 | Select appropriate engineering tools from various alternatives | 2 |
| 5.2 | Apply selected engineering tools | 2 |
| 5.3 | Recognize limitations of selected engineering tools | 2 |
| 7 | Communication skills | 1 |
| 7.1 | Develop and deliver clear, key concepts using methods appropriate for the intended audience | 1 |
| 7.2 | Critically evaluate received information | 1 |
| 7.3 | Demonstrate active listening and follow instructions | 1 |
| 9 | Impact of engineering on society and environment | 1, 3 |
| 9.1 | Analyze the social, environmental and legal aspects of engineering | 1, 3 |

| # | Outcome Set Name | Course Learning Outcome |
|---|---|---|
| | activity | |
| 9.2 | Summarize the common sources of uncertainty and risk in their engineering field | 1, 3 |
| 9.3 | Identify the impact of introducing innovative technologies to solve engineering problems | 1, 3 |

## 4.3 Relationships with other Courses and Labs

Previous Courses:

- ENGG*1100 & ENGG*2100: Core design process skills are essential for the particulate design project. Team and project management skills are equally important.
- ENGG*2560: Principles in mass balance for particle and air systems are essential in theoretical, modelling, and experimental developments.
- ENGG*2230: Motion of particles and air streams dominantly build on uid mechanic principles.
- ENGG*3260: Temperature, mass, and heat transfer e ects on particles and air systems dominantly build on thermodynamic principles.
- ENGG*3180: Air quality sets the context for the atmospheric control challenges that 4810 addresses.

Before (Regular) and After (Coop) Courses:

- ENGG*3100: Continuing to advance your design skills is essential for air pollution control.
- ENGG*3430 & ENGG*3470: Heat and Mass transfer limitations can play a signi cant role in the e ectiveness of many air pollution control solutions.
- ENGG*3410: Automated control systems play an integral role in the operation and success of a very large fraction of emission control technologies.

Follow-on Courses:

- ENGG*4130: Many final design teams and projects will draw on 4810 skills, directly benefi tting teams addressing air pollution challenges in their design work. Teams will indirectly benefi t from ENGG*4810 if they require thermodynamics, fluid mechanics, programming and/or computational fluid dynamics skills in their ENGG*4130 project.

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# 5 Teaching and Learning Activities

## 5.1 Lecture Schedule

| Date | Topics(s) | References |
|---|---|---|
| Week 0 | Introduction | Ch 1,2 |
| Week 1 | Particle Equation of Motion | Ch. 5 |
| Week 2 | Particle Size Characterization | Ch. 5 |
| Week 3 | Particle Heat and Mass Transfer | Ch. 1,5 |
| Week 4 | Turbulent Flows | Ch. 1,2 |
| Week 5 | Particle Coagulation and Nucleation | Ch. 5 |
| Week 6 | Particle Formation in Combustion, Test 1 | Ch. 6 |
| Week 7 | Settling Chambers and Cyclones | Ch. 7 |
| Week 8 | Filtration | Ch. 7 |
| Week 9 | Electrostatic Precipitation | Ch. 7 |
| Week 10 | Wet Collectors, Test 2 | Ch. 7 |
| Week 11 | Air Pollution Control Strategies | Ch. 9 |
| Week 12 | Wrap-up | |

## 5.2 Lab/Tutorial Schedule (Approximate)

Computer labs and tutorials will run continuously during all weeks except for dates exempted in the undergraduate calendar. Students will be noti ed and reminded for these dates via the CourseLink. Students will use these computer labs and tutorials to learn the course material and ask questions at their own pace. Their computer lab work, however, will be marked. Experimental labs will be run according to a time table to be posted in CourseLink.

## 5.3 Important Dates

Mon. Aug. 21: add period for Fall semester 2017 begins
Mon. Sep. 4: holiday
Thu. Sep. 7: first day of classes
Fri. Sep. 15: add period ends
Mon. Oct. 9: holiday, no classes or labs, classes rescheduled to Fri. Dec. 1
Tue. Oct. 10: study break day, no classes or labs, classes rescheduled to Thu. Nov. 30
Fri. Nov. 3: 40th class day, last day to drop one semester course
Wed. Nov. 29: Last regular day of classes
Thu. Nov. 30: classes rescheduled from Tue. Oct. 10, Tue. schedule in effect
Fri. Dec. 1: classes rescheduled from Mon. Oct. 9, Mon. schedule in effect

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# 6 Assessments

## 6.1 Marking Schemes & Distributions

Computer labs (individual): In these labs you should guide yourself by the instruction sheets and complete various scripts in MATLAB to perform particle simulations. You should be able to reproduce results in the form of numbers, text files, or graphs from the instructions and answer question, verbally, to the instructor or teaching assistant to receive a mark for each lab you successfully complete.

Experimental lab (group): You will attend the lab in small groups and, with the help of the lab technician, you will perform the experiments and collect the data. You later prepare a lab report with your team-mates and submit it via the Dropbox in CourseLink.

Simulation projects (group): With the knowledge gained in the computer labs you will write MATLAB scripts to perform particle simulations, given necessary resources from the instruc- tor, and you prepare project reports with your team-mates and submit it via the Dropbox in CourseLink.

Term tests (individual): These tests will be held in class. No electronic device, except for a non-programmable calculator, is allowed. All aid sheets including lecture notes and text books are allowed.

Essay in engineering and science (group): You will submit an essay about the biography of an engineer or scientist whose theories we will introduce and use in this course. The submission is via Dropbox in CourseLink.

Note: lab and project groups will be announced in CourseLink.

| Name | Scheme A (%) |
|---|---|
| Computer labs: In lab assessment | 20.00 |
| Experimental lab: Lab report | 10.00 |
| Simulation Project 1: Project report 1 | 10.00 |
| Simulation Project 2: Project report 2 | 10.00 |
| Term Test: In class test 1 | 20.00 |
| Term test: in class test 2 | 20.00 |
| Essay in engineering and science | 10.00 |
| Total | 100.00 |

## 6.2 Assessment Details

**Computer labs: In lab assessment**

**Date:**

Weekly

**Experimental lab: Lab report**

**Date:** Sunday, December 3

**Simulation Project 1: Project report 1**

**Date:** Sunday, October 29

**Simulation Project 2: Project report 2**

**Date:** Sunday, November 26

**Term Test: In class test 1**

**Date:** Thursday, October 19

**Term test: in class test 2**

**Date:** Thursday, November 16

**Essay in engineering and science**

**Date:** Sunday, November 12

## 6.3 Course Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. Please see below for specific details and consult the undergraduate calendar for information on regulations and procedures for Academic Consideration:

http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations:

http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Passing grade: The passing grade for this course is 50%.

Missed tests: If you miss a test due to grounds for granting academic consideration or religious accommodation, the instructor will distribute the mark associated with that test to other course deliverables in a mutual agreement with the student. There will be no make-up tests.

Experimental Lab Work: You must attend and complete the experimental lab. If you miss the lab due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to join another group. If you do not complete the pre-lab safety quiz, you will not be permitted to complete the lab. Students who miss laboratories and are not granted accommodation will not receive a mark for the project associated with the lab, regardless of the mark received by other group members.

Late Submissions: Late (> 4 hours) submissions will be penalized if there are not acceptable compassionate or medical grounds. A 30% penalty will be applied for reports submitted between 4 and 72 hours late. Reports received more than 72 hours will not be evaluated.

Team Work: Team work is required for various deliverables above. If there is some observation

or evidence that you have not been an approximately equal contributor to the work then you will be asked to provide evidence of your individual efforts, contributions and results. Keeping a logbook may be one effective means to help demonstrate your contributions.

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# 7 School of Engineering Statements

## 7.1 Instructor's Role and Responsibility to Students

The instructor’s role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

## 7.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

## 7.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

# 8 University Statements

## 8.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

## 8.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The regulations and procedures for Academic Consideration are detailed in the Undergraduate Calendar.

## 8.3 Drop Date

Courses that are one semester long must be dropped by the end of the fortieth class day; two-semester courses must be dropped by the last day of the add period in the second semester. The regulations and procedures for Dropping Courses are available in the Undergraduate Calendar.

## 8.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

## 8.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required, however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance, and not later than the 40th Class Day.

More information: www.uoguelph.ca/sas

## 8.6 Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy is detailed in the Undergraduate Calendar.

## 8.7 Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

## 8.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.

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