This course is an introduction to the diverse nature of the air pollution problem, and atmospheric dispersion
of air pollutants. It introduces the student to aspects of physics, epidemiology, legislation, chemistry,
technology, meteorology, and dispersion modeling relevant to air pollution, and develops the basic skills
required to evaluate air pollution problems. The general objectives of the course are to:

• identify, formulate, analyse and solve air pollution and design problems while working individually or
functioning on a team.

• apply knowledge of chemistry and mathematics to the analysis of fate and transport of air pollutants.

• develop an awareness of contemporary air pollution problem and appreciate professional responsibility
issues;

• recognize the need for life-long learning to keep abreast of new designs and pollution control methods,
enhance one’s abilities as a designer, and maintain one’s professional competence.

Calendar Copy:
This course is an introduction to the diverse nature of the air pollution problem, and atmospheric dispersion
of air pollutants. It introduces the student to aspects of physics, epidemiology, legislation, chemistry,
removal technology, meteorology, and dispersion modeling relevant to air pollution, and develops the basic
skills required to evaluate air pollution problems.

Contact Hours:
2 lecture hours; 2 tutorial hours each week; Attendance at the tutorial session is mandatory

Prerequisites:
Completion of second year of the Engineering Science or Science Program
or permission of the Department

Note: It is the student's responsibility to ensure that all Prerequisite and Corequisite conditions are met or
that special permission to waive these requirements has been granted by the Faculty. It is also the student's
responsibility to ensure that they have not taken a course listed as an Antirequisite. The student may be
dropped from the course or not given credit for the course towards their degree if they violate the
Prerequisite, Corequisite or Antirequisite conditions.

Corequisites:
None

Antirequisites:
None
Contact Hours:
2 lecture hours; 2 tutorial hours each week
Note: It is the student's responsibility to ensure that all Prerequisite and Corequisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. It is also the student's responsibility to ensure that they have not taken a course listed as an Antirequisite. The student may be dropped from the course or not given credit for the course towards their degree if they violate the Prerequisite, Corequisite or Antirequisite conditions.

Instructor:
Dr. M. Ray (TEB 443); Tel. 661-2111 ext. 81273; email: mray@eng.uwo.ca
Dr. G. Nakhla (SEB 3037); Tel. 661-2111 ext. 85470; email: gnakhla@eng.uwo.ca

Textbook:

Other References:
Course Notes: To be provided; posted at the WEBCT

Laboratory Notes:
None

Units:
SI units will be used in lectures and examinations

Specific Learning Objectives:

Introduction
At the end of this topic, students should be able to:
• perform basic chemistry calculations and unit interconversions

Air Pollution Effects
At the end of this topic, students should be able to:
• relate to the common indoor and outdoor problems.

Air Quality Standards and Regulation
At the end of this topic, students should be able to:
• perform simple health risk calculations using given risk factors
• appreciate the interplay of various factors in the regulation of air pollution
• understand the principal aspects of air pollution regulation

Air Pollution Sources
At the end of this topic, students should be able to:
• identify the sectoral origins of major air pollutants in North America
• calculate air pollutant emission rates, given emission factors

Atmospheric Chemistry of Sulfur and Nitrogen
At the end of this topic, students should be able to:
• describe the atmospheric chemistry of sulfur and nitrogen compounds relevant to acidic deposition
Particulate Air Pollution
At the end of this topic, students should be able to:
• appreciate the origin, nature, fate and impact of atmospheric particulates
• use design techniques to remove particulates

Combustion as a Source of Air Pollutants
At the end of this topic, students should be able to:
• calculate the volume and composition of gases evolved by fuel combustion
• identify the major variables affecting formation of nitrogen oxides in combustion processes
• describe the principal pollutants emitted by internal combustion engines, and factors affecting their formation

Photochemical Air Pollution
At the end of this topic, students should be able to:
• describe the formation of secondary pollutant due to photochemical reactions

Atmospheric Dispersion
At the end of this topic, students should be able to:
• calculate dispersion of pollutants in atmosphere based on meteorology
• calculate stack height for pollutant release

Source Reduction
At the end of this topic, students should be able to:
• identify strategies and technologies for reducing emissions of particulates and gases

Indoor air pollution
At the end of this topic, students should be able to:
• identify indoor air pollutants and predict the concentration of pollutant using systems approach

Particulate Pollutants Control
At the end of this topic, students will be able to:
• understand various forces governing particulate movement
• design gravity settlers and cyclones

Incineration & Thermal Oxidation
At the end of this topic, students will be able to:
• perform mass and energy calculations
• design vapor/gas incinerators with afterburners

Scrubbers/Absorption Systems
At the end of this topic, students will be able to:
• design packed beds, bubble plates and tray absorbers
• select scrubbing liquid and determine flows
• calculate pressure drops across beds

Adsorption Systems
At the end of this topic, students will be able to:
• understand the adsorption process and adsorption equilibrium models
• design fixed-bed adsorbers and estimate service life
Biological Control Systems
At the end of this topic, students will be able to:
• understand various systems including biofilters, biotrickling filters, and bioscrubbers
• perform design calculations for biological systems
• understand impact of design and operational parameters on system performance

General Learning Objectives

E=Evaluate, T=Teach, I=Introduce

<table>
<thead>
<tr>
<th>Problem Analysis</th>
<th>T</th>
<th>Team Work</th>
<th>I</th>
<th>Ethics and Equity</th>
<th>I</th>
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</thead>
<tbody>
<tr>
<td>Investigation</td>
<td>I</td>
<td>Communication</td>
<td>T</td>
<td>Economics and Project Management</td>
<td>I</td>
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<tr>
<td>Design</td>
<td>T</td>
<td>Professionalism</td>
<td>T</td>
<td>Life-Long Learning</td>
<td>T</td>
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<tr>
<td>Engineering Tools</td>
<td>T</td>
<td>Impact on Society</td>
<td>I</td>
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Evaluation:
The final course mark will be determined as follows:
- Weekly Assignments: 20%
- Midterm Examination: 30% (open book) (to be decided by the end of September)
- Final Exam: 50% (open book)

(Notes: (1) Students must pass the final examination to pass this course. Students who fail the final examination will be assigned the aggregate mark, as determined above, or the examination mark, whichever is less. Assignments are to be handed in the CEE 4405 locker (#61) on the specified due date provided by the Instructor. (2) Students who have failed this course previously must repeat all components of the course. No special permissions will be granted enabling a student to retain assignment or test marks from previous years. Previously completed assignments cannot be resubmitted.

Plagiarism Checking:
The University of Western Ontario uses software for plagiarism checking. Students are required to submit their Laboratory Reports in electronic form to Turnitin.com for plagiarism checking.

Cheating:
University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties that might include expulsion from the program. If you are caught cheating, there will be no second warning.

For more information on scholastic offenses, please see:
http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf

Attendance:
Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the
Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

**Accessibility:**
Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

**Conduct:**
Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others. Late comers may be asked to wait outside the classroom until being invited in by the Instructor. Please turn off your cell phone before coming to a class, tutorial, quiz or exam.

On the premises of the University or at a University-sponsored program, students must abide by the Student Code of Conduct: [http://www.uwo.ca/univsec/board/code.pdf](http://www.uwo.ca/univsec/board/code.pdf)

**Sickness and Other Problems:**
Students should immediately consult with the Instructor or Department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see attached). The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, please see: [http://www.uwo.ca/univsec/handbook/appeals/accommodation_medical.pdf](http://www.uwo.ca/univsec/handbook/appeals/accommodation_medical.pdf)

**Notice:**
Students are responsible for regularly checking their email, course website ([https://owl.uwo.ca](https://owl.uwo.ca)) and notices posted outside the Civil and Environmental Engineering Department Office

**Consultation:**
Students are encouraged to discuss problems with their teaching assistant and/or instructor in tutorial sessions. Office hours will be arranged for the students to see the instructor and teaching assistants. Other individual consultation can be arranged by appointment with the appropriate instructor.

**Course breakdown:**
Natural Science = 25%; Engineering Science = 30%; Engineering design = 20%; Complementary Studies = 10%; Mathematics = 15%.

**Use of English:**
In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.
**Attendance**
Any student, who, in the opinion of the instructor, is absent too frequently from class or laboratory or tutorial periods in any course, will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular examination in the course.

**Accessibility:**
Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Student with Disabilities (SSD) at 661-2111 x82147 for any specific question regarding an accommodation.

**Cheating**
University policy states that cheating is a scholastic offense. The commission of a scholastic offense is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence.

The University of Western Ontario has software for plagiarism checking. Students may be required to submit their work in electronic form for plagiarism checking.

For further information on plagiarism, consult the Scholastic Offence Policy in the Western Academic Calendar, the course instructor, or access the following website:
http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergraduate.pdf

**Conduct:**
Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others. Late comers may be required to wait outside until being invited in by the Instructor. Please turn off your cell phone before coming to a class, tutorial, or exam.

On the premises of the University or at a University-sponsored program, students must abide by the Student Code of Conduct:
http://www.uwo.ca/univsec/board/code.pdf

**Sickness and Other Problems:**
Students should immediately consult with the instructor or Department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see attached). The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, please see:
http://www.uwo.ca/univsec/handbook/appeals/accommodation_medical.pdf

**Notice:**
Students are responsible for regularly checking their email and notices posted on Instructors' doors.
Consultation:
Students are encouraged to discuss problems with their teaching assistant and/or instructor in tutorial sessions. Office hours will be arranged for the students to see the instructor and teaching assistants. Other individual consultation can be arranged by appointment with the appropriate instructor.

Course Breakdown:

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>Basic Science</td>
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<tr>
<td>Engineering Science</td>
<td>14</td>
</tr>
<tr>
<td>Engineering Design</td>
<td>11.8</td>
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</tbody>
</table>

September 7, 2017
INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED

IF, ON MEDICAL OR COMPASSIONATE GROUNDS, YOU ARE UNABLE TO WRITE TERM TESTS OR FINAL EXAMINATIONS OR COMPLETE COURSE WORK BY THE DUE DATE, YOU SHOULD FOLLOW THE INSTRUCTIONS LISTED BELOW. YOU SHOULD UNDERSTAND THAT ACADEMIC RELIEF WILL NOT BE GRANTED AUTOMATICALLY ON REQUEST. YOU MUST DEMONSTRATE TO YOUR DEPARTMENT (OR THE UNDERGRADUATE SERVICES OFFICE) THAT THERE ARE COMPELLING MEDICAL OR COMPASSIONATE GROUNDS THAT CAN BE DOCUMENTED BEFORE ACADEMIC RELIEF WILL BE CONSIDERED. DIFFERENT REGULATIONS APPLY TO TERM TESTS, FINAL EXAMINATIONS AND LATE ASSIGNMENTS. PLEASE READ THE INSTRUCTIONS CAREFULLY. (SEE THE 2017 UWO ACADEMIC CALENDAR).

A. GENERAL REGULATIONS & PROCEDURES

1. All first year students will report to the Undergraduate Services Office, SEB 2097, for all instances.

2. If you are an upper year student and you are missing a test/assignment/lab or exam that is worth MORE THAN 10% of your final grade, you will report to the Undergraduate Services Office, SEB 2097. Otherwise, you will report to your department office to request relief.

3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.

4. Documentation must be provided as soon as possible. If no one is available in your Department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.

5. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or examination reweighted on a retroactive basis is not permitted.

B. TERM TESTS

1. If you are in first year and you are unable to write a term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.

2. If you are an upper year student and you are unable to write a term test, inform your instructor PRIOR to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office. If the test is worth MORE THAN 10% of your final grade you will report to the Undergraduate Services Office, SEB 2097 to request relief. Otherwise, you will report to your department office to request relief.

3. Be prepared to provide supporting documentation to the Department Chair and/or the Undergraduate Services Office (see next page for information on documentation).

4. Discuss with the instructor if and when the test can be rescheduled. N.B. The approval of the Chair or the Undergraduate Services Office is required when rescheduling term tests.

C. FINAL EXAMINATIONS

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number.

2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, sleeping in, misreading timetable and travel arrangements.

3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department and the Associate Dean and in order to apply you must sign a "Recommendation for a Special Examination Form" available in the Undergraduate Services Office. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

N.B. It is the student's responsibility to check the date, time and location of the Special Examination.

D. LATE ASSIGNMENTS

1. Advise the instructor if you are having problems completing the assignment on time (prior to the due date of the assignment).

2. Be prepared to provide documentation if requested by the instructor (see reverse side for information on documentation).

3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Associate Dean if you are in first year) is not required if assignments will be completed prior to the last day of classes.

4. i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean. Documentation is mandatory.

4. ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean.
If you miss a class due to a minor illness or other problem, check your course outlines for information regarding attendance requirements and make sure you are not missing a test, laboratory or assignment. Cover any readings and arrange to borrow notes from a classmate.

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You may want to seek advice from the academic counsellor in your Department or Ms. Karen Murray in the Undergraduate Services Office, if you are in first year.

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, you must provide the doctor with a Student Medical Certificate to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office). This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor’s notes will not be accepted; only the Student Medical Certificate will be accepted.

In Case of Serious Illness of a Family Member: Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

In Case of a Death: Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

For Other Extemuating Circumstances: If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

1. You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).

2. You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.

3. If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your academic counsellor.

Absences Due to Illness: [http://westerncalendar.uwo.ca/2017/pg117.html](http://westerncalendar.uwo.ca/2017/pg117.html)
Academic Accommodations for Students with Disabilities: [http://westerncalendar.uwo.ca/2017/pg118.html](http://westerncalendar.uwo.ca/2017/pg118.html)
Academic Accommodations for Religious or Holy Days: [http://westerncalendar.uwo.ca/2017/pg117.html](http://westerncalendar.uwo.ca/2017/pg117.html)
Course Withdrawals: [http://westerncalendar.uwo.ca/2017/pg119.html](http://westerncalendar.uwo.ca/2017/pg119.html)
Examinations: [http://westerncalendar.uwo.ca/2017/pg129.html](http://westerncalendar.uwo.ca/2017/pg129.html)
Scheduling of Term Assignments: [http://westerncalendar.uwo.ca/2017/pg135.html](http://westerncalendar.uwo.ca/2017/pg135.html)
Scholastic Offences: [http://www.westerncalendar.uwo.ca/2017/pg111.html](http://www.westerncalendar.uwo.ca/2017/pg111.html)
Student Medical Certificate: [http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf)

Note: These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

**Drop Deadlines:**
- First term half course (i.e. “A” or “F”): November 5, 2017
- Full courses and full-year half courses (i.e. “E”, “Y” or no suffix): November 30, 2017
- Second term half or second term full course (i.e. “B” or “G”): March 7, 2017

**Contact Information:**
- Undergraduate Services Office: SEB 2097 Telephone: (519) 661-2130 E-mail: engugrad@uwo.ca
- Dept. of Chemical and Biochemical Engineering & Green Process Engineering: TEB 477 Telephone: (519) 661-2131 E-mail: cheugrad@uwo.ca
- Dept. of Civil and Environmental Engineering: SEB 3005 Telephone: (519) 661-2139 E-mail: civil@uwo.ca
- Dept. of Electrical and Computer Engineering, Software Engineering & Mechatronics Engineering: TEB 279 Telephone: (519) 661-3758 E-mail: eceugrad@uwo.ca
- Dept. of Mechanical and Materials Engineering: SEB 3002 Telephone: (519) 661-4122 E-mail: mmeundergraduate@uwo.ca

Revised 07/07/17