This form is to be used when proposing a new CAS or GRS course.

This form should be submitted to Senior Academic Administrator Peter Law (617-353-7243) as a PDF file to pgl@bu.edu. For further information or assistance, contact Associate Dean Susan Jackson (617-353-2410; sjackson@bu.edu) about CAS courses or Associate Dean Jeffrey Hughes (617-353-2690; hughes@bu.edu) about GRS courses.

DEPARTMENT OR PROGRAM: Earth and Environment

CAS

DATE SUBMITTED: September 16, 2016

COURSE NUMBER: ES 540

COURSE TITLE: Air Pollution and Global Change

INSTRUCTOR(S): Geddes

TO BE FIRST OFFERED: Sem./Year: Spring/2017

SHORT TITLE: The “short title” appears in the course inventory, on the Link University Class Schedule, and on student transcripts and must be 15 characters maximum including spaces. It should be as clear as possible.

An introduction to the chemistry and physics of atmospheric pollution, and the impacts of air pollution on human welfare and the environment. The course highlights the interactions between air quality, the biosphere, climate, and sustainable development.

PREREQUISITES: Indicate “None” or list all elements of the prerequisites, clearly indicating “AND” or “OR” where appropriate. Here are three examples: “Junior standing or CAS ZN300 or consent of instructor”; “CAS ZN108 and CAS ZN203 and CAS PQ206; or consent of instructor”; “For SED students only.”

1. State the prerequisites:

CH 101; MA 123 (MA 124 recommended); ES/GE 270 or an equivalent statistics course from another department.

2. Explain the need for these prerequisites:
Students will need some familiarity with basic chemical principles (the periodic table, chemical transformations, reaction rate expressions), and the ability to understand a differential equation. Course activities will involve some statistical analysis (e.g. calculating averages, and identifying outliers).

CREDITS: (check one)

☐ Half course: 2 credits
☐ Variable: Please describe.
☒ Full course: 4 credits
☐ Other: Please describe.

Provide a rationale for this number of credits, bearing in mind that for a CAS or GRS course to carry 4 credits, 1) it must normally be scheduled to meet at least 150 minutes/week, AND 2) combined instruction and assignments, as detailed in the attached course syllabus, must anticipate at least 12 total hours/week of student effort to achieve course objectives.

Students will have 180 min of class meeting per week. In addition to classroom contact time, students should expect to spend 8-10 hours per week to complete readings, prepare to participate in class discussions, complete homework, and complete writing assignments.

DIVISIONAL STUDIES CREDIT: Is this course intended to fulfill Divisional Studies requirements?

☒ No
☐ Yes. If yes, please indicate which division ________________________ and explain why the course should qualify for Divisional Studies credit. Refer to criteria listed here and specify whether this course is intended for “short” or “expanded” divisional list.

HOW FREQUENTLY WILL THE COURSE BE OFFERED?

☐ Every semester  ☐ Once a year, fall  ☒ Once a year, spring  ☐ Every other year  
☐ Other: Explain:

NEED FOR THE COURSE: Explain the need for the course and its intended impact. How will it strengthen your overall curriculum? Will it be required or fulfill a requirement for degrees/majors/minors offered by your department/program or for degrees in other departments/school/colleges? Which students are most likely to be served by this course? How will it contribute to program learning outcomes for those students? If you see the course as being of “possible” or “likely” interest to students in another departments/program, please consult directly with colleagues in that unit. (You must attach appropriate cognate comments using cognate comment form if this course is intended to serve students in specific other programs. See FURTHER INFORMATION below about cognate comment.)

The proposed class will serve as an elective to fulfill the course requirements for the Department’s graduate programs, and will serve as an elective course for upper level undergraduates in Earth & Environmental Sciences. The course fills a current curricular gap by focusing on atmospheric processes and air pollution themes. The course will provide students with a thorough understanding of how basic chemical and physical principles shape the impact of air pollution from local to global scales. The course will focus on chemical reactions of major global atmospheric topics such as stratospheric ozone depletion, photochemical smog, and acid rain. Students will develop the ability to model atmospheric chemical transport using simple mass
balance equations. Students will be able to critically examine future challenges facing air pollution control, and identify potential solutions. Students will also gain hands-on experience with air quality monitoring data and learn how to calculate air quality exceedances relevant to policy and public health. Finally, the course culminates in discussions of how air quality relates to climate and sustainability using examples from current journal articles, giving students experience in reading and understanding air pollution science literature.

ENROLLMENT: How many undergraduate and/or graduate students do you expect to enroll in the initial offering of this course?

I anticipate enrollment of 10-20 students, with a majority being undergraduate students.

CROSS-LISTING: Is this course to be cross-listed or taught with another course? If so, specify. Chairs/directors of all cross-listing units must co-sign this proposal on the signature line below.

N/A

OVERLAP:

1. Are there courses in the Course Inventory (CC00) with the same number and/or title as this course
   x No.
   □ Yes. If yes, any active course(s) with the same number or title as the proposed course will be phased out upon approval of this proposal.

2. Relationship to other courses in your program or others: Is there any significant overlap between this course and others offered by your department/program or by others? (You must attach appropriate cognate comments using cognate comment form if this course might be perceived as overlapping with courses in another department/program. See FURTHER INFORMATION below.)

   There is no overlap in the content of this course with other courses currently offered in Earth and Environment or other departments.

FACILITIES AND EQUIPMENT: What, if any, are the new or special facilities or equipment needs of the course (e.g., laboratory, library, instructional technology, consumables)? Are currently available facilities, equipment, and other resources adequate for the proposed course? (NOTE: Approval of proposed course does not imply commitment to new resources to support the course on the part of CAS.)

This course will use current departmental resources, including university licenses for Matlab software, and use of departmental computing facilities.
STAFFING: How will the staffing of this course, in terms of faculty and, where relevant, teaching fellows, affect staffing support for other courses? For example, are there other courses that will not be taught as often as now? Is the staffing of this course the result of recent or expected expansion of faculty? (NOTE: Approval of proposed course does not imply commitment to new resources to support the course on the part of CAS.)

This course will be taught by a new hire in the EE department (Geddes) and will not adversely affect net departmental course staffing.

BUDGET AND COST: What, if any, are the other new budgetary needs or implications related to the start-up or continued offering of this course? If start-up or continuation of the course will entail costs not already discussed, identify them and how you expect to cover them. (NOTE: Approval of proposed course does not imply commitment to new resources to support the course on the part of CAS.)

No additional items are requested for this course.

EXTERNAL PROGRAMS: If this course is being offered at an external program/campus, please provide a brief description of that program and attach a CV for the proposed instructor.

FURTHER INFORMATION THAT MUST BE ATTACHED IN ORDER FOR THIS PROPOSAL TO BE CONSIDERED:

A complete week-by-week SYLLABUS with student learning objectives, readings, and assignments that reflects the specifications of the course described in this proposal; that is, appropriate level, credits, etc. (See guidelines on “Writing a Syllabus” on the Center for Excellence & Innovation in Teaching website.) Be sure that syllabus includes your expectations for academic honesty, with URL for pertinent undergraduate or GRS academic conduct code(s).

Cognate comment from chairs or directors of relevant departments and/or programs. Use the form here under “Curriculum Review & Modification.” You can consult with Susan Jackson (CAS) or Jeffrey Hughes (GRS) to determine which departments or programs inside and outside of CAS would be appropriate.

DEPARTMENT CONTACT NAME AND POSITION: Dave Marchant, Dept Chair
DEPARTMENT CONTACT EMAIL AND PHONE: MARCHANT@BU.EDU 617-353-3236

DEPARTMENT APPROVAL: ________________________________  ________________________________
Department Chair  Date  Date

__________________________________________  ________________________________
Other Department Chair(s) (for cross-listed courses)  Date
CAS/GRS CURRICULUM COMMITTEE APPROVAL:

☐ Approved  Date: ______________________
☐ Tabled   Date: ______________________
☐ Not Approved  Date: ______________________

Divisional Studies Credit:

☐ Endorsed
  ☐ HU
  ☐ MCS
  ☐ NS
  ☐ SS

☐ Not endorsed

______________________________________________________________
Curriculum Committee Chair Signature and Date

Comments:

PROVISIONAL APPROVAL REQUESTED for Semester/Year ______________________

______________________________________________________________
Dean of Arts & Sciences Signature and Date

Comments:

CAS FACULTY:  Faculty Meeting Date: ______________________  ☐ Approved  ☐ Not Approved

______________________________________________________________
Curriculum Administrator Signature and Date

Comments:
ES 540 – Air Pollution and Global Change

Course Website:

Syllabus – Spring 2017
Instructor: Jeffrey Geddes

Office: CAS 439F
Email: jgeddes@bu.edu
Office Phone: 358-0208

Class Meeting:

Class: 
Office Hours: by appointment

Course Overview:

Air pollution is an important environmental issue and a public health concern. This course will introduce the chemical and physical processes that determine air quality impacts at local and global scales. By studying the chemistry of ozone depletion, photochemical smog, and acid rain, students will learn how basic chemical principles (e.g. kinetics, thermodynamics, photochemistry, and redox reactions) apply to the understanding of our atmosphere as a chemical system. Atmospheric transport as the mechanism through which air quality evolves from a local problem to a transboundary and global issue will be explored. The effects of air pollution on human health and the environment (including climate change) will be highlighted, and students will learn about methods of air pollution monitoring and control technologies. The course will culminate in discussions of the interactions between air quality, the biosphere, global climate, and sustainability by studying examples from primary literature. Students will be required to read and discuss current scientific literature on atmospheric chemistry, and will learn how to analyze air quality data sets using computer software. Class meetings will involve a combination of lectures and active group discussion.

Course Goals:

(1) Gain an understanding of, and appreciation for, the fundamental chemical reactions that control air quality
(2) Recognize how meteorology drives the extent of air pollution damage, and create simple models of chemical mass transport.
(3) Anticipate the future challenges facing air pollution control in the US and around the world, and identify potential solutions
(4) Develop the ability to critically read primary literature on air pollution research, and to communicate the science to a lay audience
(5) Develop skills in analyzing real air quality monitoring data using computer software, and propose hypotheses that explain observed patterns
**Prerequisites:** CH 101; MA 123 (MA 124 recommended); ES/GE 270 or an equivalent statistics course.

**Required Text:** Mark Jacobson (2012), Air Pollution and Global Warming, Cambridge University Press

**Recommended Text:** Daniel Jacob (1999), Introduction to Atmospheric Chemistry, Princeton University Press

**Additional Reading:** Readings from primary literature will be shared on blackboard.

**Assessments:**

Homework / Problem sets: 15%

Three (5% each) take-home assignments involving calculations, chemical mechanisms, and short answers.

Press Release: 10%

Select a recent article relevant to course material from *Atmospheric Chemistry and Physics* (other options: *Environmental Science & Technology, Journal of Atmospheric Chemistry, Journal of Geophysical Research-Atmospheres*). Write a short (450-550 words) “press release” for a lay audience describing the main results, how they were achieved, and why they are of importance. Examples of scientific press releases can be found from BU Research at: [http://www.bu.edu/research/articles/](http://www.bu.edu/research/articles/) or from Chemical & Engineering News at: [http://cen.acs.org/news.html](http://cen.acs.org/news.html). Rubric to follow.

Air Quality Monitoring Analysis: 15%

Download at least one year of publically accessible air quality data from the Boston area (or from your hometown). Analyze the data to calculate any air quality exceedances, and identify temporal (hourly, weekly, seasonal) patterns. Explain the observations based on meteorology and chemical principles. Rubric to follow.

Midterm test: 25%

Final exam: 35%

**Late Policy:** Late assignments will be accepted with a 10% penalty per day late. Once the exercise has been graded and returned to the class it will no longer be accepted. Exceptions can be made for students who proactively reach out if they are unwell.

**Academic Conduct Code:** Students are required to understand and adhere to the CAS Academic Code. The Code can be found at [http://www.bu.edu/academics/policies/academic-conduct-code/](http://www.bu.edu/academics/policies/academic-conduct-code/) for undergraduates and at [http://www.bu.edu/cas/students/graduate/forms-policies-procedures/academic-discipline-procedures/](http://www.bu.edu/cas/students/graduate/forms-policies-procedures/academic-discipline-procedures/) for graduate students. Suspected violations of the code will be discussed with the student AND reported to the Dean, and dealt with in accordance with university policy.
**Disability Accommodations:**
Accommodations for students with disabilities will be provided in accordance with the policies of Boston University.

**Lecture and Reading Schedule:**

<table>
<thead>
<tr>
<th>Week Beginning</th>
<th>Topic</th>
<th>Reading</th>
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<tbody>
<tr>
<td>16-Jan</td>
<td>No class</td>
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<tr>
<td></td>
<td>History of Air Pollution</td>
<td>Jacobson Ch. 4 (p. 73-84)</td>
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<tr>
<td>23-Jan</td>
<td>Atmospheric composition and structure, units of atmospheric concentration</td>
<td>Jacobson Ch. 3</td>
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<tr>
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<td>Chemistry concepts (1): Chemical transformations, kinetics, and rate expressions</td>
<td>Jacobson Ch. 1</td>
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<tr>
<td>30-Jan</td>
<td>Chemistry concepts (2): Radiation and photochemistry</td>
<td>Jacobson Ch. 1</td>
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<tr>
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<td>Tropospheric Chemistry: NOx-O3 System, CH4 and CO Oxidation</td>
<td>Jacobson Ch. 4 (p. 85-88)</td>
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<tr>
<td>6-Feb</td>
<td>Chemistry of urban O3 pollution</td>
<td>Jacobson Ch. 4 (p. 88-99)</td>
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<td></td>
<td>Atmospheric aerosol</td>
<td>Jacobson Ch. 5</td>
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<tr>
<td>13-Feb</td>
<td>Aqueous phase chemistry and acid rain</td>
<td>Jacobson Ch. 10</td>
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<td>Indoor air quality</td>
<td>Jacobson Ch. 9</td>
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<tr>
<td>20-Feb</td>
<td><strong>No Class (Monday Schedule)</strong></td>
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<td>Stratospheric ozone (1): Chapman mechanism, catalytic loss cycles</td>
<td>Jacobson Ch. 11</td>
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<tr>
<td>27-Feb</td>
<td>Stratospheric ozone (2): Polar stratospheric clouds</td>
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<td><strong>MIDTERM TEST</strong></td>
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<tr>
<td>6-Mar</td>
<td>No Class (Spring Recess)</td>
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<td></td>
<td>No Class (Spring Recess)</td>
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<tr>
<td>13-Mar</td>
<td>Atmospheric pollutant transport (1): Local scale meteorology and deposition</td>
<td>Jacobson Ch. 6</td>
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<td></td>
<td>Atmospheric pollutant transport (2): General circulation and long-range transport</td>
<td>Jacobson Ch. 6</td>
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<tr>
<td>20-Mar</td>
<td>Modeling atmospheric chemistry (1): Simple box models</td>
<td>Jacob Ch. 3</td>
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<tr>
<td></td>
<td>Modeling atmospheric chemistry (2): Chemical transport models</td>
<td>Bey et al. (2001)</td>
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<tr>
<td>27-Mar</td>
<td>Regulation and control</td>
<td>Jacobson Ch. 8</td>
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<tr>
<td>Date</td>
<td>Topic</td>
<td>References</td>
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<td>3-Apr</td>
<td>Health effects of air quality, dose-response, exposure, and the global burden of disease</td>
<td>Geddes et al. (2009); Martin et al. (2008)</td>
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<td>Air pollution effects on vegetation, structures, and the atmosphere</td>
<td>Jacobson Ch. 7; p. 228-235</td>
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<tr>
<td>10-Apr</td>
<td>Air quality and the biosphere</td>
<td>Monson &amp; Holland (2001); Heald and Spracklen (2015); Rea et al. (2012)</td>
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<td>Air quality and climate: Direct and indirect radiative forcing, aerosol impacts on climate</td>
<td>Jacobson Ch. 12</td>
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<tr>
<td>17-Apr</td>
<td>Impacts of global warming on air quality</td>
<td>Kinney (2008); Jacob (2009); Garcia-Menendez et al. (2015)</td>
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<td>Co-benefits of greenhouse gas mitigation</td>
<td>Thompson et al. (2014); Nemet et al. 2010</td>
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<td>24-Apr</td>
<td>The future of air pollution (1): The the 21st century and beyond</td>
<td>Pozzer et al. (2012); Lelieveld et al. (2015); Fann et al. (2013)</td>
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<td>The future of air pollution (2): Sustainability</td>
<td>Chapter 13; Marlier et al. 2016</td>
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<tr>
<td>1-May</td>
<td>Exam Review</td>
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</tbody>
</table>

**Reference list:**


Geddes JA et al. (2009), Long term changes in nitrogen oxides and volatile organic compounds in Toronto and the challenges facing local ozone control, *Atmospheric Environment*, 43:3407-3415

Heald CL and Spracklen DV (2015), Land use change impacts on air quality and climate, *Chemical Reviews*, doi:10.1021/cr500446g


Marlier et al. (2016), Extreme air pollution in global megacities, *Current climate change reports*, 2:15-27


Rea et al. (2012), Using ecosystem services to inform decisions on US air quality standards, *Environmental Science and Technology*, 46:6481-6488