Atmospheric & Oceanic Sciences 2/2L  Air Pollution  Winter 2021

AOS 2 offers an introduction to some of today’s most pressing environmental problems, such as the ozone hole, smog, climate change, etc., which are typically classified under the common term Air Pollution. Throughout the class, the different aspects of air pollution, their causes, effects, and possible solutions will be introduced.

This quarter’s AOS 2/2L course at the UCLA campus will be taught as fully online class (asynchronous online instructional modules and live online discussion sections) for both UCLA and non-UCLA students. Discussion sections are held as Zoom sessions at the times published in the Schedule of Classes; cross-campus-enrolled (i.e., non-UCLA) students can choose from any of the scheduled discussion section times or attend an evening discussion at a time to be arranged (currently scheduled for Tuesdays at 7:00 pm Pacific Time).

Enrollment

UCLA students enroll in either conventional discussion sections or online discussion sessions, corresponding to “LEC 1” in the Schedule of Classes. Cross-campus students enroll in the online course through the UC Online cross-campus site and are sent to “LEC 2” and discussion section 2A at UCLA. They will not be presented with a choice of discussion times, but can choose later to attend any of the open sections or the Tuesday evening section. Wait-listed students are not enrolled in the class and are not guaranteed enrollment. Wait-lists are erased after the second week of classes.

Please note that some of these sections may become full. There is no preferential enrollment; no PTEs will be issued for full sections. If you are dropped for any reason (usually a late fee payment), you will not be able to immediately re-enroll in a section that has a closed or wait-listed status. You will have to get on any open section or wait list; you will not be given preferential enrollment. This includes students dropped due to registrar/computer error or other administrative problems.

Online “lecture” content and “homework”: Access by logging in to our CCLE site via https://ccle.ucla.edu

Online lectures will consist of a series of short videos (or electronic slide modules), with each video having embedded quiz questions or followed by separate activities and quiz questions. This approach is intended to engage students with the material and thus improve the learning experience. To encourage timely progress, credit for completing content is closed according to the schedule appearing later in this syllabus. “Review” versions of lessons become available after each set of lessons closes. It will be possible to get credit for completing these “review” lessons after the original deadlines, but this will need to cleared with the instructor.

In some cases, the activities may need to be completed satisfactorily before students advance to the next instructional module. Viewing the videos and completing the activity questions accurately before the lessons close will earn completion points and contribute to the overall grade. Keeping a schedule is necessary so that everyone is prepared for the discussion section activities. It is strongly suggested that at the latest, lessons be attempted and completed throughout the week before they are scheduled to close. Leaving them until a few hours before they close puts you at risk of not being able to complete the lessons due to network congestion and technical difficulties. However, remember that you can generally get clearance to complete “review” lessons for credit after the published deadlines if you experience technical issues.

Some of the between-lesson activities are labeled “homework assignments”. These include a mix of fill-in-the-blank, multiple-choice, and essay questions that combine recall and application of material in the preceding set of lessons, and carry somewhat higher point totals per assignment than the lesson activities.

Students who require accommodations due to physical disabilities should contact the UCLA Center for Accessible Education (or your local campus’ disabilities office) for access to specialized equipment that will enable you to use our CCLE website and the lesson videos. Videos have closed-captioning, but there are also transcripts of the audio track along with slide images are available for everyone at the opening of the lessons.
Discussion sections

Discussion sections are conducted online with Zoom. These sessions will have individual and group activities related to course material, and review of online lecture material as needed. **Discussion sections WILL meet during Week 1 (January 4–8, 2021), but NOT during Week 6 (February 8–12, 2021).**

It is preferred that you show the section in which you are enrolled; however, there should be enough space in each section for you to attend any of the scheduled discussion sections, including the evening section. Usually, at least one of the scheduled times (including Tuesday evening) will work for students not located in the Pacific Time zone; but let us know if you require an alternate time.

Students attending online discussion sections will access them via Zoom. The meeting ID for each of the discussion sections will be published in the “Discussion Sessions” section of our CCLE course website. You must have a webcam, microphone, speakers, and a good Internet connection, though we will make accommodations for those lacking these.

The Tuesday night online section for cross-campus students (2A) is also available to any UCLA student.

If anyone does not have adequate access to resources to attend these online discussion sections, please let us know so we can suggest or provide alternatives.

**Schedule (all in Pacific Time)**

<table>
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<tr>
<th>Section</th>
<th>Time</th>
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<th>Time</th>
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<tbody>
<tr>
<td>1A</td>
<td>Tuesday 11:00–11:50 am</td>
<td>1F</td>
<td>Wednesday 1:00–1:50 pm</td>
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<tr>
<td>1B</td>
<td>Tuesday 12:00–12:50 pm</td>
<td>1G</td>
<td>Wednesday 2:00–2:50 pm</td>
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<tr>
<td>1C</td>
<td>Tuesday 1:00–1:50 pm</td>
<td>1H</td>
<td>Wednesday 7:00–7:50 pm</td>
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<tr>
<td>1D</td>
<td>Wednesday 10:00–10:50 am</td>
<td>1I</td>
<td>Thursday 7:00–7:50 pm</td>
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<tr>
<td>1E</td>
<td>Wednesday 11:00–11:50 am</td>
<td>2A</td>
<td>Tuesday 7:00–7:50 pm</td>
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</table>

Group activities completed during discussion section will be graded. Close interaction with fellow students and the teaching assistants to complete the activities is strongly encouraged.

**Discussion activities schedule by week**

1. Introduction (January 4–8)
2. Activity #1 (January 11–15)
3. Activity #2 (January 19–22)
4. Activity #3 (January 25–29)
5. Review for midterm (February 1–5)
6. No discussion, midterm (February 8–12)
7. Activity #4 (February 16–19)
8. Review (February 22–26)
9. Activity #5 (March 1–5)
10. Activity #6 (March 8–12)

**Laboratory section**

An optional lab section AOS 2L may be added upon enrollment in the AOS 2 lecture/discussion. This 1-unit section satisfies the “lab/demo” requirement for the General Education “Foundations of Scientific Inquiry”. This lab section does not have formal classroom meetings, since all assignments are posted and submitted online in the “Laboratory Assignments” section of our CCLE site. However, **this lab section must be taken during the same quarter as the lecture/discussion.** For cross-campus students, check your local campus approvals for degree credit and whether or not you need to enroll in this lab section (some of these data is in our course listing at https://crossenrollcourses.universityofcalifornia.edu).

**Instructor**

Dr. Jeffrey Lew
Zoom Meeting ID 882-261-6568
lew@atmos.ucla.edu
Office hours

Dr. Lew

Mon 1:30–3:30 pm, Thursday 1:00–3:00 pm, or by appt.
Or, email/Slack-message at any time.
(Pacific time zone)

Online via Zoom: Meeting ID 882-261-6568 or from a web browser, https://ucla.zoom.us/my/aosjefflew, unless it is during a discussion section (in which you will need to get the meeting ID from our course website)
Zoom is a web conference service that offers free accounts to all people. Information about installing client apps for various desktop/laptop computers and mobile devices are at http://zoom.us/download
UCLA students can log in and set up their account profile at https://ucla.zoom.us (UCLA students do not need to register a free account at http://zoom.us; this will be done when you first log in at the ucla.zoom.us site, using your UCLA logon credentials).
All others can register for a free account at http://zoom.us

A Slack workspace will be set up where you can shoot questions to the instructional team in near real-time, and there may be additional private Slack channels for students only (no instructor supervision). Watch for CCLE announcements about this.

Textbook (optional)
Jacobson, M.Z., *Air Pollution and Global Warming: History, Science, and Solutions*, 2nd ed. Available at the UCLA Store, various booksellers. Also available as an e-text through Cambridge Core and the UCLA Library:
https://www.cambridge.org/core/books/air-pollution-and-global-warming/88F8EDD9F3B45FDA54060AA22D8ADD15
You must be within the UCLA campus network to see this e-text. If you are off-campus, connect to the UCLA VPN first. A UCLA logon (which you should have for accessing CCLE) is required for use of the UCLA VPN:
https://www.it.ucla.edu/it-support-center/services/virtual-private-network-vpn-clients

Grades

Course grades are based on 1000 points earned from:

<table>
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<tr>
<th>Component</th>
<th>Points</th>
<th>Percentage of Total Grade</th>
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<tbody>
<tr>
<td>Discussion section group activities</td>
<td>120</td>
<td>12%</td>
</tr>
<tr>
<td>Online Lessons and Homework</td>
<td>230</td>
<td>23%</td>
</tr>
<tr>
<td>Midterm examination</td>
<td>250</td>
<td>25%</td>
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<tr>
<td>Final examination</td>
<td>400</td>
<td>40%</td>
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</table>

The optional lab section (2L) adds 200 points to this total. Students enrolled in the 2L lab section in addition to the regular course (2) will have a course grade computed from a percentage of the 1200 points earned during the quarter. These students will have the same final course grade posted on their transcripts for both 2 and 2L.

If you are excused from some assignments, your cumulative total will be reduced by the point value of the excused assignments. For grading purposes, your “% of total points” will be based on this new cumulative total.

The course will be graded on a fixed scale:

<table>
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<tr>
<th>Grade</th>
<th>A+</th>
<th>A</th>
<th>A−</th>
<th>B+</th>
<th>B</th>
<th>B−</th>
<th>C+</th>
<th>C</th>
<th>C−</th>
<th>D+</th>
<th>D</th>
<th>D−</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of total points</td>
<td>96</td>
<td>92</td>
<td>88</td>
<td>84</td>
<td>80</td>
<td>76</td>
<td>72</td>
<td>66</td>
<td>60</td>
<td>54</td>
<td>48</td>
<td>42</td>
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Students taking the course with P/NP grading basis will pass with a “P” grade after earning the equivalent of a grade “C” or higher.
Homework

We expect that students submit homework that represents what you as an individual would write, as if the assignment was given to you in an examination. It is permissible to consult with other students in the course or with tutors or instructors; however, it is not permissible for you to simply copy another student's answers, or text from another source (internet, books, etc.) and submit it as your own. It is also not permissible for other students to write up your homework assignment for you, unless this has been arranged through the Center for Accessible Education (CAE).

Examinations

Midterm (through ozone hole) Tuesday, February 9, 2021, 6:00–7:15 pm
Final (cumulative) Wednesday, March 17, 2021, 6:30–9:30 pm

All students will be taking online versions of the exams (both UCLA and cross-campus). The Respondus Lockdown Browser with webcam monitor will be used, at no additional cost to the students, unless an alternate remote proctor service is contracted by the University of California. Note that the Respondus Browser requires either Windows or MacOS; no other operating systems are supported.

If you do not have the equipment or Internet connection to take an online exam with the Respondus Lockdown Browser, let us know so we can arrange an alternate exam for you. See “Policies” below if you are not located in the Pacific time zone.

Examination Policies

1) There will be no makeup and no alternate-scheduled (i.e., “early”) exams, unless otherwise required by CAE and California Education Code Section 92640(a).
   a. This policy assumes “normal” conditions. However, COVID-19 mandates, civil unrest, residing in non-Pacific time zones, family emergencies, wildfire evacuations, etc. have made these times anything but normal. We can usually accommodate any reasonable request for alternate times or alternate exams, subject to University grade deadlines.

2) Students who normally require the assistance of CAE to take exams must consult with the instructor as soon as possible regarding test-taking procedures.

3) Examinations are multiple-choice, fill-in-the-blank, and short-essay. They include material from the lecture, homework, and the discussion sections.

4) Examinations are closed-book. Reference materials, such as notes, textbooks, and online course materials are prohibited.

5) To take the exam, you must present your photo identification (student ID, driver's license, or passport) during the startup process when you launch the Respondus browser.

Laboratory Assignments (for students enrolled in 2L)

The 1-unit 2L laboratory section is an optional add-on to the standard 4-unit course, essentially making this course into a 5-unit physical science GE course with lab/demo credit. Students who do not need the lab/demo credit because they have already satisfied or intend to satisfy it with a different 5-unit GE science course may opt to not enroll in the 2L section and instead earn only 4 units of credit with the regular course. Those students do not need to complete any laboratory assignments.

The 2L laboratory section must be taken during the same quarter as the A&O Sci 2 lecture/discussion course because the scores are combined into one grade, as if one was taking a single 5-unit course. Attempting to take 2L during a quarter separate from 2 will result in a failing grade (and no lab/demo credit) in 2L.

Students enrolled in the 2L laboratory section will perform four experiments or simulations during the quarter. These assignments will be posted online in the “Laboratory Assignments” section of our CCLE site; there are no formal classroom meetings associated with the lab assignments. At the end of each assignment, a report will be submitted electronically via our CCLE site, either as a PDF file or Microsoft Word/Office document. Students may also submit a hardcopy report to any of the instructors. The report may include numerical computations, graphs, and short-answer/short-essay questions. The purpose of the laboratory is to learn how to
perform experiments to test scientific hypotheses, interpret observations, and summarize results in a concise, written form.

Lab 1: Atmospheric Methane Increase

The importance of methane as a greenhouse gas and the increase of its mixing ratio over the past 300 years raise the following questions:

- How much methane is released each year into the atmosphere?
- How can one explain the rise of atmospheric methane?
- How does this relate to global population growth?
- By how much will methane increase over the next fifty years?

In this laboratory assignment, you will learn the methods scientists use to answer these questions. In the first part of the assignment you will use the steady state box model to determine the source rates (or emission rate; source and emission rate are terms for the same quantity) for the years 1700 and 2000. The second part of the assignment will show you how one can simulate the increase of methane in the atmosphere.

Lab 2: Ozone Layer Measurements

An important part of scientific work is the presentation and analysis of observations in the atmosphere, such as those of the total ozone column (TOC). The observations reveal how the atmosphere works and thus improve our understanding of atmospheric processes. In addition, these measurements are used to monitor air pollution effects such as the ozone hole.

In this laboratory assignment, we will study how the ozone layer varies over different parts of the Earth, and learn how scientists present and interpret observational data. We will use observations from NASA’s Aura satellite that is currently flying around the Earth making measurements of total ozone columns. Specifically, we want to answer the following questions:

- How does the TOC change with latitude?
- How does the TOC change with longitude?
- How does the TOC change over the period of a year?

Lab 3: Atmospheric Stability and Dispersion

In this lab, we will test the stability of a simulated atmospheric environment by pushing around an air parcel that is at equilibrium. We will also set up typical cases of positively buoyant air parcels and see how well they convect under different environmental conditions. Finally, we will study a case of a temperature inversion aloft and how afternoon heating of the ground affects dispersion in this type of atmosphere.

You will be plotting graphs of environmental temperature vs. altitude, called temperature soundings. These soundings can represent environmental temperature profiles with a single lapse rate (environmental lapse rate, ELR or $\Gamma_e$ or $\gamma$) or multiple lapse rates. On these plots, you will also be plotting the temperature inside a rising air parcel as a function of altitude. These plot lines will represent temperature trajectories of the air parcels, and will have a fixed, common slope that corresponds to the dry adiabatic lapse rate (ALR or $\Gamma_d$ or just $\Gamma$).

For the temperature inversion cases, we will use an online air parcel motion simulator that allows us to configure different types of temperature inversion profiles and shows the expected motion of buoyant air parcels released in those environments.

Lab 4: Real-time Aerosol Particulate Observations

In this laboratory assignment, we will explore the potential of new low-cost sensor networks to monitor air pollution concentrations.

One such network has thousands of sensor units around the world monitoring PM2.5 concentration. We will acquire data from this network for locations in Los Angeles and in other countries to see if the data correlate with what we know about the geography and meteorology of the regions.
Schedule of Topics

Lessons will begin opening sequentially as of the start of the quarter (January 4, 2020). Lessons close at 11:55 pm on the closing date. Ideally, you will have started each lesson set about the time they open and gradually work through each section day-to-day until the closing date of that section. **Note that you may not be able to start lessons until the previous lesson or homework assignment in sequence has been completed.** See the CCLE course website for specific opening/closing dates of individual lessons and homework assignments.

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<thead>
<tr>
<th>Section</th>
<th>WEEK 1</th>
<th>Closing date</th>
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<tbody>
<tr>
<td>1. <strong>Introduction / Motivation</strong></td>
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<tr>
<td>1.1 What is “Air Pollution”?</td>
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<td>1.2 How does air pollution impact our lives?</td>
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<tr>
<td>2. <strong>Measurements, Chemistry, and Concentrations</strong></td>
<td>Mon., 1/11/21</td>
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<tr>
<td>2.1 Introduction / Definitions</td>
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<tr>
<td>2.2 Chemistry</td>
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<td>2.3 The Steady State Box Model</td>
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<td>3. <strong>Atmospheric Evolution</strong></td>
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<td>Mon., 1/18/21</td>
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<td>3.1 Primordial Atmosphere</td>
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<td>3.2 Secondary Atmosphere</td>
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<td>3.3 Nitrification</td>
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<td>3.4 Catastrophic Atmosphere-changing Events</td>
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<td>3.5 Human Impact</td>
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<td>4. <strong>The Atmosphere</strong></td>
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<td>Mon., 1/25/21</td>
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<td>4.1 Atmospheric Structure</td>
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<td>4.2 Atmospheric Gases</td>
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<td>4.3 Aerosol Particles</td>
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<td><strong>HOMEWORK ASSIGNMENT #1</strong> (due Thursday, January 21, 2021)</td>
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<td>5. <strong>Global Climate Change</strong></td>
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<td>Mon., 2/1/21</td>
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<td>5.1 Introduction</td>
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<td>5.2 Atmospheric Radiation</td>
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<td>5.3 Atmospheric Greenhouse Effect</td>
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<td>5.4 Global Climate Change</td>
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<td>5.5 Remediation</td>
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<td><strong>HOMEWORK ASSIGNMENT #2</strong> (due Thursday, January 28, 2021)</td>
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<td>6. <strong>Stratospheric Ozone Depletion</strong></td>
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<td>Mon., 2/1/21</td>
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<td>6.1 Introduction</td>
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<td>6.2 Ozone Layer</td>
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<td>6.3 Health Effects</td>
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<td>6.4 Chlorofluorocarbons (CFCs)</td>
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<td>6.5 Ozone Chemistry and the Ozone Hole</td>
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<td>6.6 Regulation and Abatement</td>
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<td><strong>HOMEWORK ASSIGNMENT #3</strong> (due Thursday, February 4, 2021)</td>
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No online lessons this week…study for midterms!
WEEK 6
MIDTERM EXAMINATION
Tuesday, February 9, 2021, 6:00–7:15 pm
Covers Sections 1–6, Homework #1–2, Discussion Activities #1–3

7. Air Pollution Toxicity
   7.1. Risk Assessment Tools
   7.2. Quantifying Health Effects
   7.3. Physiological Effects on Humans
   7.4. Examples

WEEK 7

8. Air Pollution Meteorology
   8.1. Transport Processes
   8.2. Atmospheric Stability and Convective Dispersion
   8.3. Temperature Inversions
   8.4. Impact on Daily and Seasonal Smog Variation
   8.5. Application: Chimney Plumes
   8.6. Plume Type vs. Stability
   8.7. Enhancing Plume Dispersion

WEEK 8

9. Acid Rain / London Smog
   9.1. Brief History
   9.2. London Smog
   9.3. Acids / Bases
   9.4. The Sulfur Cycle
   9.5. The Nitrogen Cycle
   9.6. Acid Rain
   9.7. Environmental and Health Effects
   9.8. Abatement

WEEK 9

10. Los Angeles Smog
    10.1. History of Smog in Los Angeles
    10.2. Components of Los Angeles Smog
    10.3. Ozone Formation
    10.4. Smog and Visibility
    10.5. Smog Meteorology
    10.6. Air Pollution Mitigation
    10.7. The Future of LA Smog

HOMEWORK ASSIGNMENT #4 (due Thursday, March 10, 2021)

WEEK 10

11. Indoor Air Pollution
    11.1. Indoor Air Pollution
    11.2. Sources and Health Effects
    11.3. Indoor Air Pollution Remediation

HOMEWORK ASSIGNMENT #5 (due Thursday, March 11, 2021)

FINAL EXAMINATION: Wednesday, March 17, 2021, 6:30–9:30 pm (covers everything in the course)