Syllabus

CLIM 456 Introduction to Atmospheric Radiation
Spring 2021
TR 12:00 pm – 1:15 pm
ON LINE

Instructor: Cristiana Stan
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703-993-5391
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Course Credits: 3
Course Website: Blackboard
Office Hours: Monday – 1:00pm-2:30pm

***Prerequisites*:** CLIM 111, MATH 114 and PHYS 216 or permission of instructor

***Catalog Description*:** Provides fundamentals, physical understanding and quantitative analysis of radiative transfer in the atmosphere, discusses radiation processes- reflection, refraction, absorption, transmission, emission, and scattering and introduces tools for atmospheric radiative transfer calculations. Provide students the basics for more advanced topics such as remote sensing or satellite meteorology.

Objectives: Provides undergraduate students in atmospheric sciences a basic grounding in the principles of atmospheric radiation. In particular:
1. Students will show an understanding of atmospheric radiation processes;
2. Students will recognize the mathematical framework and physical principles of atmospheric radiation;
3. Students will use the mathematical skill and physical principles to solving atmospheric radiation problems;

***Required Text*:**
Petty, G., A First Course in Atmospheric Radiation, 2nd Edition, Sundog Publishing, Wisconsin, Madison, USA

Assignments:
Periodic homework is assigned and is due at the start of the class indicated. Late submission without a grade penalty will be accepted only in case of sickness or pre-approval from instructor granted on the day the homework is assigned. Homework will be graded and returned. For each homework, you will submit a reflection which will allow you to think critically about the work you did after you have completed it. Students are required to keep a journal for the course and submit journal entries periodically. There will be one midterm exam during the semester and a Final. Exams are designed to test basic concepts and are closed books and closed notes.

Late assignments: 10% is taken off for up to three days late; 30% is taken off for work submitted up to a week late. No assignment is accepted after one week, except for special extensions granted on the day the homework is assigned.

***Grading*:**
Homework: 40%
Homework reflection: 10%

Class journal: 10%
Midterm: 20%
Final: 20%

Course Outline

1. Introduction
   1.1 Relevance to Climate and Weather
   1.2 Relevance to Remote Sensing
2. Properties of Radiation
   2.1 The Nature of Electromagnetic Radiation
   2.2 Frequency
   2.3 Polarization
   2.4 Energy
   2.5 A Mathematical Description of EM Waves
   2.6 Quantum Properties of Radiation
   2.7 Flux and Intensity
   2.8 Insolation
3. The Electromagnetic Spectrum
   3.1 Frequency, Wavelength and Wavenumber
   3.2 Major Spectral Bands
   3.3 Solar and Terrestrial Radiation and Energy
4. Reflection and Refraction
   4.1 Index of Refraction
   4.2 Reflection and Refraction
   4.3 Rainbows and Halos
5. Radiative Properties and Natural Surfaces
   5.1 Natural Surface Idealized as Planar Boundaries
   5.2 Absorption and Reflectivity
   5.3 Angular Distribution of Reflected Spectra
   5.4 Solar Heating and Vis/IR Satellite Imaging
6. Thermal Emission
   6.1 Blackbody Radiation
   6.2 Emissivity
   6.3 Thermal Emission Applications
   6.4 Radiative Cooling and Global Radiation Balance
7. Atmospheric Transmission
   7.1 Extinction, Scattering and Absorption Coefficients
   7.2 Extinction over a Finite Path
   7.3 Plane Parallel Approximation
   7.4 Optical Thickness and Transmission of clouds
8. Atmospheric Emission
   8.1 Schwazschild's Equation
   8.2 Radiative Transfer in a Plane Parallel Atmosphere
   8.4 Emission Spectrum, Profile Retrieval and Water Vapor Imaging
9. Absorption by Atmospheric Gases
   9.1 Basis for Molecular Absorption/Emission
   9.2 Absorption/Emission Lines
   9.3 Line Shapes
   9.4 Continuum Absorption
   9.5 Atmospheric absorption in the IR

10. Broadband Fluxes and Heating Rates in the Cloud-free atmosphere
  10.1 Line-by-line Calculations
  10.2 Band Transmission Models
  10.3 The K-Distribution Method
  10.4 Fluxes and Radiative Heating/cooling
11. Radiative Transfer Equilibrium (RTE) with Scattering
  11.1 RTE with Scattering
  11.2 The Scattering Phase Function
  11.3 Single vs Multiple Scattering
  11.4 Atmospheric Visibility
12. Scattering and Absorption by Particles
  12.1 Atmospheric Particles
  12.2 Scattering by Small Particles
  12.3 Scattering by Spheres- Mie Theory
  12.4 Distribution of Particles
  12.5 Radar and Microwave Remote Sensing of Clouds
13. Radiative Transfer with Multiple Scattering
  13.1 Visualizing Multiple Scattering
  13.2 The Two-Stream Method
  13.3 Semi-Infinite Clouds
  13.4 Non-absorbing Clouds
  13.5 Clouds over Non-Black Surface
  13.6 Multiple Cloud Layers

Course Structure and Interaction:
Activities and assignments in this course will regularly use the Blackboard learning system, available at https://mymason.gmu.edu. Students are required to have regular, reliable access to a computer with an updated operating system (recommended: Windows 10 or Mac OSX 10.13 or higher) and a stable broadband Internet connection (cable modem, DSL, satellite broadband, etc., with a consistent 1.5 Mbps [megabits per second] download speed or higher.

Activities and assignments in this course will regularly use web-conferencing software (Blackboard Collaborate / Zoom). In addition to the requirements above, students are required to have a device with a functional camera and microphone. In an emergency, students can connect through a telephone call, but video connection is the expected norm.

This course requires the use of LockDown Browser and a webcam for online exams. The webcam can be built into your computer (internal webcam) or can be the type of webcam that plugs in with a USB cable (external webcam). Watch this short video to get a basic understanding of LockDown Browser and the webcam feature. A Quick Start Guide for Students is also available.

- You will need the following system requirements for online exams:
  - Windows: 10, 8, 7
  - Mac: OS X 10.10 or higher
  - iOS: 10.0+ (iPad only). Must have a compatible LMS integration [Details].
  - Web camera (internal or external) & microphone
  - A reliable internet connection
  - Prior to your first exam, you must install LockDown Browser following the step-by-step instructions.
- To ensure LockDown Browser and the webcam are set up properly, do the following:

- Start LockDown Browser, log into Blackboard and select this course.
- Locate and select the Help Center button on the LockDown Browser toolbar.
- Run the Webcam Check and, if necessary, resolve any issues or permissions your computer prompts.
- Run the System & Network Check. If a problem is indicated, see if a solution is provided in the Knowledge Base. Further troubleshooting is available through the ITS Support Center.
- Exit the Help Center and locate the practice quiz named [NOTE TO INSTRUCTOR: Create a brief practice quiz and insert name/location of quiz].
- Upon completing and submitting the practice quiz, exit LockDown Browser.

- When taking an online exam that requires LockDown Browser and a webcam, remember the following guidelines:
  - Ensure you're in a location where you won't be interrupted
  - Turn off all other devices (e.g. tablets, phones, second computers) and place them outside of your reach
  - Clear your desk of all external materials not permitted — books, papers, phones, other devices
  - Before starting the test, know how much time is available for it, and that you've allotted sufficient time to complete it
  - Remain at your computer for the duration of the testMake sure that your computer is plugged into a power source, or that battery is fully-charged.
  - If the computer or networking environment is different than what was used previously with the Webcam Check and System & Network Check in LockDown Browser, run the checks again prior to starting the test
- To produce a good webcam video, do the following:
  - Do not wear a baseball cap or hat with a brim that obscures your face
  - Ensure your computer or tablet is on a firm surface (a desk or table). Do NOT have the computer on your lap, a bed, or any other surface where the device (or you) are likely to move
  - If using a built-in (internal) webcam, avoid tilting the screen after the webcam setup is complete
  - Take the exam in a well-lit room and avoid backlighting, such as sitting with your back to a window
  - Remember that LockDown Browser will prevent you from accessing other websites or applications; you will be unable to exit the test until all questions are completed and submitted

Academic Integrity:
The integrity of the University community is affected by the individual choices made by each of us. Mason has an Honor Code with clear guidelines regarding academic integrity. Three fundamental and rather simple principles to follow at all times are that: (1) all work submitted be your own; (2) when using the work or ideas of others, including fellow students, give full credit through accurate citations; and (3) if you are uncertain about the ground rules on a particular assignment, ask for clarification. No grade is important enough to justify academic misconduct. Plagiarism means using the exact words, opinions, or factual information from another person without giving the person credit. Writers give credit through accepted documentation styles, such as parenthetical citation, footnotes, or endnotes. Paraphrased material must also be cited, using the appropriate format for this class. A simple listing of books or articles is not sufficient.

Plagiarism is the equivalent of intellectual robbery and cannot be tolerated in the academic setting. If you have any doubts about what constitutes plagiarism, please see me.

Disability Accommodations:
Disability Services at George Mason University is committed to upholding the letter and spirit of the laws that ensure equal treatment of people with disabilities. Under the administration of University Life, Disability Services implements and coordinates reasonable accommodations and disability-related services that afford equal access to university programs and activities. Students can begin the registration process with Disability Services at any time during their enrollment at George Mason University. If you are seeking accommodations, please visit http://ds.gmu.edu/ for detailed information about the Disability Services registration process. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email:ods@gmu.edu | Phone: (703) 993-2474

Notice of mandatory reporting of sexual or interpersonal misconduct:
As a faculty member, I am designated as a "Non-Confidential Employee," and must report all disclosures of sexual assault, sexual harassment, interpersonal violence, stalking, sexual exploitation, complicity, and retaliation to Mason's Title IX Coordinator per University Policy 1202. If you wish to speak with someone confidentially, please contact one of Mason's confidential resources, such as Student Support and Advocacy Center (SSAC) at 703-380-1434 or Counseling and Psychological Services (CAPS) at 703-993-2380. You may also seek assistance or support measures from Mason's Title IX Coordinator by calling 703-993-8730, or emailing *titleix@gmu.edu*.

Privacy:
Student privacy is governed by the Family Educational Rights and Privacy Act (FERPA) and is an essential aspect of any course. For this reason, students must use their MasonLive email account to receive important University information, including communications related to this class. I will not respond to messages sent from or send messages to a non-Mason email address.

Recording and/or sharing class materials:
Some kinds of participation in online study sites violate the Mason Honor code: these include accessing exam or quiz questions for this class; accessing exam, quiz, or assignment answers for this class; uploading of any of the instructor's materials or exams; and uploading any of your own answers or finished work. Always consult your syllabus and your professor before using these sites.