

CLASP 532: Radiative Transfer
Winter 2024

Instructor: Enrico Landi (elandi@umich.edu)

Credits: 4

Lecture: Tuesday-Thursday 1:30-3:30pm — 2238 SRB

Office Hours: Anytime by appointment via Zoom:

<https://umich.zoom.us/j/94200603803>

Meeting ID: 942 0060 3803

Passcode: 135564

Pre-requisites: Physics and Calculus

Required text: *A first course in atmospheric radiation (2nd Ed.)* by Grant W. Petty (Sundog Publishing, 2006, ISBN-13: 978-0-9729033-1-8)

*Available for a discounted rate of \$33.95 directly from publisher:

<http://www.sundogpublishing.com/Ordering/index.html>

Supplemental texts:

- 1) *Classical electrodynamics (3rd Ed.)* by John D. Jackson (John Wiley & Sons, Inc., ISBN-13: 978-0-471-30932-1)
- 2) *Atomic Spectroscopy and Radiative Processes*, by E. Landi degli Innocenti (Springer, ISBN-13: 978-88-470-2808-1)
- 3) *Radiative processes in astrophysics* by George B. Ribicki and Alan P. Lightman (Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, ISBN-13: 978-0-471-82759-7)
- 4) *Fundamentals of Molecular Spectroscopy*, by Walter S. Struve (John Wiley & Sons, ISBN: 0-471-85424-7)

Books #2 and #3 are available for download for free through Mirlyn library. I strongly recommend you download them because they are excellent reference books, which will serve you well beyond this course.

The pdf files of the relevant chapters of books #1 and #4 will be posted on canvas well in advance the relevant lecture, in order to allow you to come to class having already read them.

Course description:

This course will provide students with the basics concepts and processes of the electromagnetic spectrum, of radiative emission, absorption and scattering, and of radiative transfer. The basic physics behind these processes will be discussed, including atomic and molecular structure and the interaction of atoms and molecules with the electromagnetic field. We will primarily apply these concepts to atmospheric science and climate physics, although some examples of applications to the solar atmosphere will also be discussed.

Course structure, policy, and Honor Code:

A - Electronic devices: In order to maintain focus and attention during lectures, [all electronic devices \(phones, tablets, personal computers\) must be turned off during class](#). You do not need to use your laptop to take notes; you can take notes on a sheet of paper. In addition, I will post all Lectures on Canvas just after class.

B - Readings: All required readings will come from Petty (the required text), or from the other books (see Supplemental Texts, above) as specified in class. Readings are listed for the expected date we will begin covering the assigned material.

It is highly recommended to download the books available on Mirlyn at the beginning of the course. The relevant chapters of the other books will be posted on Canvas well before the relevant lecture (see above).

C - Homework: There will be 6 homework sets, assigned as specified in the syllabus. You may form study groups to discuss homework problems and approaches, *but your homework responses must be prepared and completed individually, using your own formulations and wording.* Verbatim copying the work (of any type) of another student is strictly forbidden (see Honor Code, below at F). You may not consult homework solutions from a previous term unless they are made available in a publicly accessible form. You may complete these assignments in *legible* written or typed form, but the final upload will need to be in PDF format.

D - Deadlines: All deadlines are strict. *Each assignment needs to be uploaded on canvas by 6:00pm on the deadline day, as noted in the syllabus* (early submissions are welcome). Late submission will not be accepted but rather will count as a missed assignment, and given a 0 grade (*which will count for the final homework grade average*).

E - Exams: There will be no “in class” final exam, similar in spirit to the homework. It will be a take home exam and you will be given a fixed time to complete it.

F - Honor code: We will follow all policies of the Honor Code, which can be found at

<http://www.engin.umich.edu/students/honorcode>

G - Class format and attendance policy: This course will be in person and attendance is mandatory. Attending classes will help you better understand the material, and will allow you to ask questions, so it is a fundamental part of the course. *If circumstances force you to miss more a class, please send an email to the Instructor before you miss the class.*

Grading:

Homework:	50%
Final exam:	35%
Participation	15%

Homework grade (50%) will be assigned on the average of the grades of the six homework sets (including those where the deadline was missed). Each homework will be graded from 0 to 100; *missed homework will be given a 0 grade and will count for the final average.*

Final grade will be based on absolute performance (i.e., grading is non-competitive). We will follow this fixed scale:

	A	92.50 to 100	A-	90.00 to 92.49	
B+	87.50 to 89.99	B	82.50 to 87.49	B-	80.00 to 82.49
C+	77.50 to 79.99	C	72.50 to 77.49	C-	70.00 to 72.49
D+	67.50 to 69.99	D	62.50 to 67.49	D-	60.00 to 62.49
E+	57.50 to 59.99	E	52.50 to 57.49	E-	50.00 to 52.49
F	49.99 and below				

SCHEDULE OF LECTURES AND ASSIGNMENTS

(BLACK: LECTURE; BLUE: ASSIGNMENT GIVEN; RED: ASSIGNMENT DUE)

Date	Lecture	Topic	Reading	Homework
Th Jan 11		Introduction	Petty Ch.1	
Tu Jan 16	I	Fundamentals of EM radiation	Jackson Ch. 6,7 Petty Ch.2	
Th Jan 18				
Tu Jan 23				
Th Jan 25	II	Reflection and refraction/Radiative properties of surfaces	Petty Ch.4-5	
Tu Jan 30				HW 1 Assigned
Th Feb 1	III	The EM spectrum and insolation	Petty Ch.3	
Tu Feb 6		NO CLASS		
Th Feb 8	IV	Thermal radiation	Petty Ch.6 Landi Ch.10.4,10.5	
Tu Feb 13				HW 1 Due 11:00pm HW 2 Assigned
Th Feb 15	V	Atmospheric transmission	Petty Ch.7	
Tu Feb 20				
Th Feb 22		NO CLASS - Instructor's travel		HW 2 Due 11:00pm HW 3 Assigned
Feb 27-29		SPRING BREAK		
Tu Mar 5	VI	Atmospheric Emission	Petty Ch.8	
Th Mar 7				
Tu Mar 12	VII	Atmospheric absorption	Petty Ch.9 Landi Ch.6, CH.7	HW 3 Due 11:00pm HW 4 Assigned
Th Mar 14				
Tu Mar 19				
Th Mar 21	VIII	Broadband fluxes	Petty Ch.10	HW 4 Due 11:00pm HW 5 Assigned
Tu Mar 26		NO CLASS - Instructor's travel		
Th Mar 28				

Date	Lecture	Topic	Reading	Homework
Tu Apr 2		<i>NO CLASS - Instructor's travel</i>		
Th Apr 4	IX	Radiative transfer and scattering	Petty Ch.11	<i>HW 5 Due 11:00pm</i> <i>HW 6 Assigned</i>
Tu Apr 9	X	Scattering and absorption	Petty Ch.12 Ribicki Ch.3	
Th Apr 11				
Tu Apr 16	XI	Multiple Scattering	Petty Ch.13	
Th Apr 18		<i>STUDY DAY</i>		<i>HW 6 Due 11:00pm</i>
Tu Apr 23		<i>FINAL EXAM RELEASED</i>		
Wed May 1		<i>FINAL EXAM DUE 6:00pm</i>		