

Syllabus
Astronomy 418/518
Astronomical Instrumentation
Fall 2021

Lectures: MW 1pm, Steward Observatory 208 and Online when needed.
See D2L for zoom link

Instructor and Contact Information:

Dr. Erika Hamden
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(520) 621-9524
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Office Hours: By Appointment

Course Overview:

Astronomy 418/518 is a 2-credit course on astronomical instrumentation given at the advanced undergraduate (418) or graduate (518) level. It is one of the required courses for the graduate astronomy program but has also proven relevant for students in planetary sciences and optical sciences, among other areas. The course is intended for scientists and engineers who will be future users of astronomical instrumentation, as well as those interested in building operating such systems.

Course Objectives:

- Students will understand the interplay between radiation, photon detection, and detector design
- Students will gain an advanced understanding of X-Ray, Optical, Infrared, and Radio instrumentation used in astronomy sufficient to:
 1. Plan and execute sophisticated observing programs and data analysis
 2. Understand strengths and limitations of various instruments used in modern astronomy
 3. Understand the design processes involved in creation of a new astronomical instrument
- Students in 518 will develop expertise with communicating fundamental astronomical concepts in a written format.

Expected Learning Outcomes:

- Students will apply principles of radiative transfer and semiconductor physics to draw conclusions about such fundamental concepts as signal to noise, limiting sensitivity, and throughput.
- Students will synthesize learning to develop comprehensive proposals for observing time and instrument work.

- Students will be able to identify and critically evaluate instrument functionality and limits at a range of wavelengths.

Evaluation, Assignments and Exams:

During this class, students in 518 will write and edit a mock instrument proposal as a semester long project. All students will be evaluated on a set of homework assignments (3), and a midterm. There will be a final for students taking 418, although they can opt into an instrument proposal group and use that score for their final exam grade.

HW 1: Due Class 8

Midterm Exam: Take-home during Class 15

HW 2: Due Class 18

Project 2- Instrument proposal: Due Class 25(518 only)

HW 3: Due Class 27

Final- (418 only)

Grading for 518 will be based on a mid-term exam (30%); an instrument project (40%); and homework (10% each).

Grading for 418 will be based on a mid-term exam (24%), a final exam (40%) that will be divided roughly 2/3 on the material since the mid-term and 1/3 comprehensive for the course, and homework (36% total).

Final Examination or Project:

The mock instrument proposal will serve as a final exam for 518 only. A final exam will be conducted for 418 students. Students in 418 can request to join an instrument proposal team in place of taking the final.

Required Textbooks:

"Measuring the Universe," G. H. Rieke, Cambridge University Press

"Electronic Imaging in Astronomy", 2nd Ed. I. S. McLean, Springer

Course Prerequisites or Co-requisites:

The course assumes a minimum preparation of Math 122B or 125 (Calculus I), Math 129 (Calculus II), Math 223 (Vector Calculus), Math 254 (Differential Equations), Physics 141/161 (Intro. Mechanics), and Physics 142/162 (Intro Thermal and Optical Phys.) or admission into the astronomy graduate program. In addition to these, ASTR 300A/B, 302, and PHYS 305 are highly recommended. Potential students who are unsure of their level of preparation should consult the instructors.

Grading Scale and Policies:

The course is normally given for standard (ABCDE) grades, but 418 can be taken as pass/fail.

The grading scale will be A: >85%; B: 70 – 85%; C: 60-70%; D: 50-60%; E: <50%. This is the scale for both the final grade and all assignments.

Grading for 518 will be based on a mid-term exam (30%); an instrument project (40%); and homework (30%).

Grading for 418 will be based on a mid-term exam (24%), a final exam (40%) that will be divided roughly 2/3 on the material since the mid-term and 1/3 comprehensive for the course, and homework (36%).

Graduate Specific Policies:

Graduate students in 518 will be responsible for developing an instrument proposal as part of this course. They will not take the Final exam.

Scheduled Topics:

Week 1: Intro to Optics and Project
Week 2: Photon detection and Radiometry
Week 3: Optics, Aberrations, Telescopes
Week 4: Optics, Pupils, Stops
Week 5: Arrays and Detectors, CCDs
Week 6: Readout and SNR, Non-CCD detectors
Week 7: Cameras and Project 1
Week 8: Midterm and Adaptive Optics
Week 9: Midterm Review and Interferometry
Week 10: Data Analysis and Astrometry
Week 11: Non-telescope instruments and Photometry
Week 12: Spectroscopy
Week 13: Polarimetry and IR
Week 14: UV & Radio
Week 15: X-ray and MRI Panel Review

A variety of other policies:

For in-person classes, COVID guidelines as set by the University will be followed.

NO smoking, eating, drinking (except water), or pets are allowed in class. Please **turn off** your cell phones and avoid disrupting the students around you, even if not explicitly described in this section! Be respectful of the other students who want to learn.

Absence and Class Participation Policy

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: <http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop>

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, <http://policy.arizona.edu/human-resources/religious-accommodation-policy>.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: <https://deanofstudents.arizona.edu/absences>

Classroom Behavior Policy:

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Students are asked to refrain from disruptive conversations with people sitting around them during lecture. Students observed engaging in disruptive activity will be asked to cease this behavior. Those who continue to disrupt the class will be asked to leave lecture or discussion and may be reported to the Dean of Students.

Threatening Behavior Policy

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See <http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students>.

Accessibility and Accommodations

Our goal in this classroom is that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact the Disability Resource Center (520-621-3268) to establish reasonable accommodations. For additional information on the Disability Resource Center and reasonable accommodations, please visit <http://drc.arizona.edu>.

If you have reasonable accommodations, please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate.

Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Code of Academic Integrity

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: <http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity>.

The University Libraries have some excellent tips for avoiding plagiarism, available at <http://www.library.arizona.edu/help/tutorials/plagiarism/index.html>.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

UA Nondiscrimination and Anti-harassment Policy

The University of Arizona is committed to creating and maintaining an environment free of discrimination. In support of this commitment, the University prohibits discrimination, including harassment and retaliation, based on a protected classification, including race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, or genetic information. For more information, including how to report a concern, please see <http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy>

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

Additional Resources for Students

UA Academic policies and procedures are available at <http://catalog.arizona.edu/policies>

Student Assistance and Advocacy information is available at <http://deanofstudents.arizona.edu/student-assistance/students/student-assistance>

Confidentiality of Student Records

<http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa>

Assistance:

If you anticipate barriers related to the format or requirements of this course, please meet with me so that we can discuss ways to ensure your full participation in the course. If you determine that disability-related accommodations are necessary, please register with **Disability Resources** (621-3268; drc.arizona.edu) and notify me of your eligibility for reasonable accommodations. We can then plan how best to coordinate your accommodations.

The University of Arizona provides a wide variety of resources to help you feel more at home in the UA environment. Examples of student resource/cultural centers include:

African-American Student Affairs Center. <https://aasa.arizona.edu/>

Asian & Pacific American Student Affairs Center <https://apasa.arizona.edu/>

Guerrero Student Center <https://chsa.arizona.edu/>

Immigrant Student Resource Center <https://eao.arizona.edu/isrc>

LGBTQ+ Student Affairs Center <https://lgbtq.arizona.edu/>
Native American Student Affairs Center <https://nasa.arizona.edu/>
Transfer Student Center <https://transfer.arizona.edu/>
Veterans Education and Transition Services Center <https://vets.arizona.edu/>
Women & Gender Resource Center <https://wrc.arizona.edu/>

We encourage you to take advantage of the community, support, and learning opportunities afforded by these centers, and to encourage your friends and colleagues to do the same.

Subject to Change:

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.