

Department of Astronomy and Planetary Science
AST 580: Techniques in Observational Astronomy Syllabus
Fall 2023

Class Information

Course Credits: 4

Prerequisites: Graduate Status

Modes of Instruction

AST 580 (Lecture)

Tuesdays and Thursdays 9:35-10:50 AM in Geology (Building 12), Room 109

Instructor: Dr. Cristina Thomas

Office: Physical Sciences (Building 19), Room 225E

Email: Cristina.Thomas@nau.edu (Please include AST 580 in the subject of all email)

Office Hours: By appointment (in person or on zoom)

Class questions or feedback can be sent anonymously here: <https://forms.gle/9NSgWnRpEEar1oJu8>

AST 580 (Lab)

Wednesdays 2:20-4:50 PM in Physical Sciences (Building 19), Room 232 &

7:00-9:30 PM at the Campus Observatory

Instructor: Ed Anderson

Office: Physical Sciences (Building 19), Room 318

Email: Ed.Anderson@nau.edu

Office Hours: Knock on Ed's door anytime, or by appointment

Course Purpose: The course will provide an introduction to the acquisition and reduction of modern astronomical data, emphasizing imaging, photometry, and spectroscopy. This is a technical vocational course, so although science will be discussed, it will be in the context of how astronomical observations are acquired and analyzed.

Course Student Learning Outcomes: After taking this course, students will be able to (1) operate an astronomical telescope, (2) gather data using an astronomical telescope, (3) understand the fundamentals of how a telescope works, (4) have familiarity with the wide variety of astronomical techniques and astronomical technologies available to the modern professional astronomer, and (5) be able to understand and assess the significance of recent events in astronomy.

Assignments / Assessments of Course Student Learning Outcomes: The majority of the assessments in this course will be through lecture homework and the nighttime lab. In the lecture homework, students will solve problems based on the course lectures and readings. The laboratory homework will provide an assessment of the hands-on technical portion of this course. Students will also be assessed based on course attendance and class participation. There will be 2 midterm exams and 1 final exam.

Field Trip: There will be an opportunity for students to take a field trip to the 4.3 meter Lowell Discovery Telescope in Happy Jack. The trip is not required and will be discussed during lecture.

Assessment & Grading

Letter grades will be assigned as follows: A \geq 90%, B = 80-89.9%, C = 70-79.9%, D = 60-69.9% and F below 60%. The requirements for grades may be relaxed based on class performance, but they will not be made more stringent.

Final Exam: The registrar has scheduled our final exam on **Tuesday Dec 12 7:30am - 9:30am**. Since this is a frustrating time, we will hold the final exam virtually that day (12:00 am-11:59 pm) with an extended time for completion. The final will be **worth 15% of your grade**. Material on the final exam will be limited to subjects that you have seen at least twice: in homework, lecture, or reading.

Mid-Term Exams: There will be two mid-term exams. The dates are noted in the Lecture Schedule. These will cover any material that has appeared in a homework assignment. These will **each be worth 5% of your grade**.

Homework & Final Presentation: There will be 8 homework assignments over the course of the semester and a final presentation. Homework will not be assigned on weeks before midterm exams (so that homework is not due at the time of an exam) or the last week. Each new homework will be announced in class and assigned through Canvas following lecture. They will be due on Canvas a week later by 11:59 pm. The final presentations will be on the last day of class (Thursday December 7). These assignments will be **worth 25% of your grade**. This is the largest part of your grade in the lecture course.

Attendance & Participation: Attendance and in-class participation are **each worth 5% of your grade for a total of 10%**.

Final Grade: Your final grade will be the same for both the lecture and lab. **Your grade will be calculated as 60% from the lecture (as described above) and 40% from the lab.**

Extra Credit: There is extra credit for attending any Department of Astronomy and Planetary Science or Lowell Observatory Colloquium. Attend and write two paragraphs with the speaker's name and describe (1) the instrumental setup the speaker used, (2) one of the main conclusions, and (3) what the speaker might be doing in the future along this line of research. One colloquium is equivalent to 20% of a single homework. If you attend 5 colloquia, it is the equivalent of 1 homework assignment. Lectures shorter than one hour do not count for this unless there are multiple lectures that fill an hour and you can summarize them all. Extra credit will also be given to those who view and write a brief description of the annular eclipse on October 14, 2023. Extra credit must be turned in within a week of the event.

Readings & Materials

Suggested Textbook: Birney, Gonzalez, Oesper, *Observational Astronomy*, Second Edition. There will be some readings from this book. Cline Library has a copy and it is available as an eTextbook on Amazon for rental for \$32.24. I will provide any excerpts that are required reading for this course so you are not required to buy this book.

Required supplementary readings will be made available on Canvas.

Computer: You will need a computer to complete nearly all assignments. If you do not have one, you can use the department computer lab or rent one from Cline Library.

Top Hat: NAU offers use of Top Hat as an alternative to clickers. We will use Top Hat throughout the semester for online polling and attendance.

Calculator: A scientific calculator will be useful for in-class exams. You will not be allowed to use your phone or computer during exams. The Cline Library rents these for free if you do not already have one or want to purchase one.

Paper and pencil.

Lecture Schedule

Here is the anticipated schedule for the semester. The schedule will likely have some adjustments based on the pace of the class. Some classes might move to zoom in the event of adverse weather or illness. If I need to move to zoom, I will cancel in-person class and notify the class by email prior to 7:30 am (2 hours before class) the morning of class.

| Week | | T | Th | Topics |
|------|-----------|----------|---------------------------------------|---|
| 1 | August | 29 | | Introduction, Syllabus |
| | | | 31 | Units, Celestial Sphere, Naked Eye Astronomy |
| 2 | September | 5 | | Time: Day, Archeoastronomy |
| | | | 7 | Time: Sidereal, Year |
| 3 | | 12 | | DST, Light |
| | | | 14 | Light, Snell's Law |
| 4 | | 19 | | Planck, Rainbows, Luminosity, Flux |
| | | | 21 | Autumnal Equinox, Wien's, Rayleigh-Jeans |
| 5 | | 26 | | SNR, Telescopes |
| | | 28 | | Telescopes, Diffraction Limit |
| 6 | October | 3 | | Midterm Review (asynchronous) |
| | | | 5 | MIDTERM 1 |
| 7 | | 10 | | Eclipses |
| | | | 12 | Guest Lecture (Lisa Prato, Lowell Observatory) |
| 8 | | 17 | | CCDs, Surveys |
| | | | 19 | Colors |
| 9 | | 24 | | Guest Lecture (Andy Lopez Oquendo) |
| | | | 26 | Magnitudes, Atmosphere |
| 10 | | 31 | | Magnitude Calibration, CCD Calibration |
| | | November | | 2 |
| 11 | 7 | | | Midterm Review |
| | | | 9 | MIDTERM 2 |
| 12 | 14 | | | Binaries, Spectroscopy |
| | | | 16 | Spectroscopy, Doppler |
| 13 | 21 | | | Astronomical Distance Scale |
| | | | 23 | - NO CLASS - THANKSGIVING DAY |
| 14 | 28 | | | Supernovae, Neutron Stars, Redshift |
| | 30 | | DART Observations & Planetary Defense | |
| 15 | December | 5 | | Class Review |
| | | | 7 | Grad Student Presentations |
| | | | | FINAL EXAM: TUESDAY DECEMBER 12 7:30-9:30am* |

Class Policies

Lecture Attendance: If you are healthy, you are expected to attend every lecture. If you have any symptoms of any kind of sickness, please do not come to lecture. You may miss 2 lectures over the semester without penalty (no excuse needed) if you notify the instructor ahead of time. Institutional or medical excuses do not count towards the 2 classes you can miss. If you are sick, please email the instructor prior to class and your attendance score will not be impacted. I will generally grant additional absences for research-related matters (e.g., conferences) if notified in advance.

Lecture slides will be made available for all classes. I do not plan on live-streaming class, but will record the class if students are out due to sickness or other excused absences. The class will not be formally hybrid because in-person teaching formats have better engagement and learning outcomes than a remote environment. An online lecture may be assigned if the instructor is ill or on travel.

Homework: All homework will be done through Canvas. For all homework, as in science, you may work together. Please understand that solving problems by yourself is a core skill in academic inquiry. All submitted homework must be written yourself and any images submitted should be taken by you. You cannot copy and distribute content to other students. You must reference other people that helped you with the homework.

There will be exercises where a calculation is required. In these problems, **you must show your work in enough depth that a typical student in the class could follow your reasoning.** This is because (1) if you make a mistake in computing the final answer, you can still get partial credit for the approach you use and (2) when doing example calculations in real life (such as in a published paper or thesis), you will have to show your work so that others can follow.

You can turn in 2 lecture homework assignments in this course 3 days late for full credit if you notify me *prior* to the original deadline. No other excuse is needed. A more lenient late policy would delay the timely return of the homeworks to all students which makes it difficult to prepare for exams. **No homework will be accepted beyond the 3 day extension.**

Exam Policies

I am planning to hold all exams through Canvas. The exam will be posted for 24 hours and the time limit will be at least twice the expected time to complete. If you need a schedule accommodation, please notify the instructor at least a week prior to the scheduled exam. Exams will be open note and internet. You will still be much better off studying for the exam ahead of time rather than trying to find solutions on the internet due to the complexity of the problems. Required physical constants will be

supplied as will fundamental formulae. Final formulae will not necessarily be provided as sometimes you may have to derive formulae yourself based on given constants and formulae depending on the problem.

Exams are designed to test individual knowledge. There may be opportunities for group work on tests, but these will be clearly announced ahead of time. In the absence of such an announcement, working together on a test, even virtually, is considered cheating.

As in the homework, all exam work must be shown for full credit.

Plagiarism and Cheating: Plagiarism is using someone else's work or ideas and passing them off as your own (and in fact, you can even self-plagiarize, but that's probably not relevant to this class). Plagiarism is considered the most serious breach of scientific integrity. Evidence of this is work suspiciously similar to other's work (exact same wording or very similar wording) with no attribution. This is considered cheating in this course. All people involved in cheating and/or plagiarism will be given a zero on the assignment or exam and will be reported to the Department Chair. Repeat offenses will be escalated to the Dean following the NAU Academic Integrity Policy.

E-learning Resources Policy: Much of our course work will take place electronically, including (but not limited to) out-of-class communication, presentation of reading materials, distribution of homework and any virtual lectures. It is the responsibility of the student to check email and Canvas regularly. The student must also allow ample time prior to deadlines to navigate any technological issues that may arise such as computer crashes, internet outages, and software version mismatches. Students are also strongly encouraged to back up all data. ITS has an excellent support network and students having issues with online learning are encouraged to contact them.

Academic Contact Hour Policy: The Arizona Board of Regents Academic Contact Hour Policy (ABOR Handbook, 2-224) states that for a 4 credit course such as this one, a student should expect to spend a **minimum** of 12 hours per week on average. Class time is 2.5 hours per week of lecture and 2.5 hours per week of lab. Therefore, at least 7 hours per week should be spent outside of class on homework, studying, preparation, and the nighttime lab.

Financial Hardship: If you are experiencing financial hardship that makes it difficult for you to meet the class requirements, please communicate with me and we will find an accommodation.

Disability Resources: If disability accommodations would benefit you, please contact the Disability Resource office at NAU (DR.Registration@nau.edu, (928) 523-8773). Many services and accommodations are available at no cost to NAU students.

University Policies: The following pages contain the NAU Policy Statements for Course Syllabi. They take precedence over anything earlier in this document.

SYLLABUS POLICY STATEMENTS

ACADEMIC INTEGRITY

NAU expects every student to firmly adhere to a strong ethical code of academic integrity in all their scholarly pursuits. The primary attributes of academic integrity are honesty, trustworthiness, fairness, and responsibility. As a student, you are expected to submit original work while giving proper credit to other people's ideas or contributions. Acting with academic integrity means completing your assignments independently while truthfully acknowledging all sources of information, or collaboration with others when appropriate. When you submit your work, you are implicitly declaring that the work is your own. Academic integrity is expected not only during formal coursework, but in all your relationships or interactions that are connected to the educational enterprise. All forms of academic deceit such as plagiarism, cheating, collusion, falsification or fabrication of results or records, permitting your work to be submitted by another, or inappropriately recycling your own work from one class to another, constitute academic misconduct that may result in serious disciplinary consequences. All students and faculty members are responsible for reporting suspected instances of academic misconduct. All students are encouraged to complete NAU's online academic integrity workshop available in the E-Learning Center and should review the full *Academic Integrity* policy available at <https://policy.nau.edu/policy/policy.aspx?num=100601>.

COPYRIGHT INFRINGEMENT

All lectures and course materials, including but not limited to exams, quizzes, study outlines, and similar materials are protected by copyright. These materials may not be shared, uploaded, distributed, reproduced, or publicly displayed without the express written permission of NAU. Sharing materials on websites such as Course Hero, Chegg, or related websites is considered copyright infringement subject to United States Copyright Law and a violation of NAU Student Code of Conduct. For additional information on ABOR policies relating to course materials, please refer to ABOR Policy 6-908 A(2)(5).

COURSE TIME COMMITMENT

Pursuant to Arizona Board of Regents guidance (ABOR Policy 2-224, *Academic Credit*), each unit of credit requires a minimum of 45 hours of work by students, including but not limited to, class time, preparation, homework, and studying. For example, for a 3-credit course a student should expect to work at least 8.5 hours each week in a 16-week session and a minimum of 33 hours per week for a 3-credit course in a 4-week session.

DISRUPTIVE BEHAVIOR

Membership in NAU's academic community entails a special obligation to maintain class environments that are conducive to learning, whether instruction is taking place in the classroom, a laboratory or clinical setting, during course-related fieldwork, or online. Students have the obligation to engage in the educational process in a manner that does not interfere with normal class activities or violate the rights of others. Instructors have the authority and responsibility to address disruptive behavior that interferes with student learning, which can include the involuntary withdrawal of a student from a course with a grade of "W". For additional information, see NAU's *Disruptive Behavior in an Instructional Setting* policy at <https://nau.edu/university-policy-library/disruptive-behavior>.

NONDISCRIMINATION AND ANTI-HARASSMENT

NAU prohibits discrimination and harassment based on sex, gender, gender identity, race, color, age, national origin, religion, sexual orientation, disability, veteran status and genetic information. Certain consensual amorous or sexual relationships between faculty and students are also prohibited as set forth in the *Consensual Romantic and Sexual Relationships* policy. The Equity and Access Office (EAO) responds to complaints regarding discrimination and harassment that fall under NAU's *Nondiscrimination and Anti-Harassment* policy. EAO also assists with religious accommodations. For additional information about nondiscrimination or anti-harassment or to file a complaint, contact EAO located in Old Main (building 10), Room 113, PO Box 4083, Flagstaff, AZ 86011, or by phone at 928-523-3312 (TTY: 928-523-1006), fax at 928-523-9977, email at equityandaccess@nau.edu, or visit the EAO website at <https://nau.edu/equity-and-access>.

TITLE IX

Title IX of the Education Amendments of 1972, as amended, protects individuals from discrimination based on sex in any educational program or activity operated by recipients of federal financial assistance. In accordance with Title IX, Northern Arizona University prohibits discrimination based on sex or gender in all its programs or activities. Sex discrimination includes sexual harassment, sexual assault, relationship violence, and stalking. NAU does not discriminate on the basis of sex in the education programs or activities that it operates, including in admission and employment. NAU is committed to providing an environment free from discrimination based on sex or gender and provides a number of supportive measures that assist students, faculty, and staff.

One may direct inquiries concerning the application of Title IX to either or both the Title IX Coordinator or the U.S. Department of Education, Assistant Secretary, Office of Civil Rights. You may contact the Title IX Coordinator in the Office for the Resolution of Sexual Misconduct by phone at 928-523-5434, by fax at 928-523-0640, or by email at titleix@nau.edu. In furtherance of its Title IX obligations, NAU promptly will investigate or equitably resolve all reports of sex or gender-based discrimination, harassment, or sexual misconduct and will eliminate any hostile environment as defined by law. The Office for the Resolution of Sexual Misconduct (ORSM): Title IX Institutional Compliance, Prevention & Response addresses matters that fall under the university's Sexual Misconduct policy. Additional important information and related resources, including how to request immediate help or confidential support following an act of sexual violence, is available at <https://in.nau.edu/title-ix>.

ACCESSIBILITY

Professional disability specialists are available at Disability Resources to facilitate a range of academic support services and accommodations for students with disabilities. If you have a documented disability, you can request assistance by contacting Disability Resources at 928-523-8773 (voice), 928-523-8747 (fax), or dr@nau.edu (e-mail). Once eligibility has been determined, students register with Disability Resources every semester to activate their approved accommodations. Although a student may request an accommodation at any time, it is best to initiate the application process at least four weeks before a student wishes to receive an accommodation. Students may begin the accommodation process by submitting a self-identification form online at <https://nau.edu/disability-resources/student-eligibility-process> or by contacting Disability Resources. The Director of Disability Resources, Jamie Axelrod, serves as NAU's Americans with Disabilities Act Coordinator and Section 504 Compliance Officer. He can be reached at jamie.axelrod@nau.edu.

RESPONSIBLE CONDUCT OF RESEARCH

Students who engage in research at NAU must receive appropriate Responsible Conduct of Research (RCR) training. This instruction is designed to help ensure proper awareness and application of well-established professional norms and ethical principles related to the performance of all scientific research activities. More information regarding RCR training is available at <https://nau.edu/research/compliance/research-integrity>.

MISCONDUCT IN RESEARCH

As noted, NAU expects every student to firmly adhere to a strong code of academic integrity in all their scholarly pursuits. This includes avoiding fabrication, falsification, or plagiarism when conducting research or reporting research results. Engaging in research misconduct may result in serious disciplinary consequences. Students must also report any suspected or actual instances of research misconduct of which they become aware. Allegations of research misconduct should be reported to your instructor or the University's Research Integrity Officer, Dr. David Faguy, who can be reached at david.faguy@nau.edu or 928-523-6117. More information about misconduct in research is available at <https://nau.edu/university-policy-library/misconduct-in-research>.

SENSITIVE COURSE MATERIALS

University education aims to expand student understanding and awareness. Thus, it necessarily involves engagement with a wide range of information, ideas, and creative representations. In their college studies, students can expect to encounter and to critically appraise materials that may differ from and perhaps challenge familiar understandings, ideas, and beliefs. Students are encouraged to discuss these matters with faculty.

Last revised August 17, 2023