

**Department of Astronomy and Planetary Science
AST 401/401L Observational Astronomy Syllabus**

2019 Fall

4 Credit Units (Combined AST 401/401L)
Corequisites AST 401 and AST 401L must be taken together
Updated August 26, 2019

Prerequisite: AST 280

Mode of Instruction:

AST 401 (Lecture)

- Meets Tuesdays and Thursdays 9:35 - 10:50am in Bldg. 19, Room 321.
- Instructors: Dr. Chad Trujillo Email: chad.trujillo@nau.edu
Office: Physical Sciences (#19) 312 Office phone: 523-6007
Office Hours: Thu 11am – noon, Wed 10am – 11:00am and by appointment
Availability: Phone response will be within an hour if a message is left, weekday emails will generally be responded to within a day.
- Instructors: Dr. David Trilling Email: david.trilling@nau.edu
Office: Physical Sciences (#19) 207 Office phone: 523-5505
Office Hours: Mon 2:30pm – 3:30pm, Tue 2pm – 3pm and by appointment
Availability: Phone response will be within an hour if a message is left, weekday emails will generally be responded to within a day.
- You can also send class questions or feedback anonymously to <https://goo.gl/forms/BSvNSPSML7WXMzm22>.

AST 401L (Lab)

- Meets Wednesdays 2:20pm – 4:50pm in Bldg. 19, Room 232 and 7:00pm – 9:30pm at the Campus Observatory.
 - Instructor: Ed Anderson Email: Ed.Anderson@nau.edu
Office: Physical Science (#19) 211 Office phone: 523-7096
Office hours: Knock on Ed's door anytime, or by appointment.
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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 based on technical advances in astronomical observations.

Assignments / Assessments of Course Student Learning Outcomes: The majority of the assessments in this course will be through homework and the nighttime lab. In the homework, students will solve problems based on the course lectures and the textbook 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. Additionally, there will be 2 term exams and 1 final exam. Exams are being given because (1) it is primarily an individual effort, which is an important aspect of research to practice, and (2) studies show that retention is improved when students are asked to recall information through testing.

Field Trips: There will be optional field trips to Lowell Observatory's 4.3 meter Discovery Channel Telescope on two dates (to be determined in October and November). A signup for the dates will be announced during lecture and made available online through BbLearn.

Grading System: Letter grades will be assigned as follows: A at 90%, B at 80%, C at 70%, D at 60% 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 final exam will take place on Tuesday Dec 11 **7:30am - 9:30am**. This will be worth 15% of your grade. Material on the final exam (and all exams) will be limited to subjects that you have seen at least three times: once in homework, once in lecture and once in a reading.
- **Mid-Term Exams:** There will be two mid-term exams on Thu Oct 10 and Thu Nov 21. These will cover any material that you have done a homework about (and received feedback on). These will each be worth 5% of your grade.
- **Homework:** There will be 1 homework assigned each week of lecture except for the week before term exams (so you don't have homework due on the same day as an exam) and the last week (reading week). These will count for a total of 25% of your grade. These will usually be assigned through BbLearn on Thursday and be due the following Thursday by 11:59pm, also turned in through BbLearn.
- **Attendance:** Attendance and in-class participation will each count towards 5% of the grade for a total of 10% and will generally be assessed via i>clicker2.

- Lab Reports and Term Paper: There will be a lab due every week (due dates announced in lab) as well as a group term project. You may work together; however, it is essential that you individually understand the labs, as each lab builds on the previous lab. You are required to make observations at the campus telescope on Wednesday nights. The Lab Reports and Term Paper total 40% of your grade. The term paper is due in lab on Wednesday, December 4.
 - Extra Credit: There is extra credit for attending the Astronomy and Planetary Science 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 of 20% of a single homework, so 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.
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Readings and Materials:

- i>clicker2 remote: **Bring this to every class.** Many of the students already have this from other classes. They are available at the NAU Bookstore for \$60 (new) to \$30 (rent, used); they are also available on Amazon for a similar price. You can alternatively get REEF polling access on your smartphone for \$16.50 for 6 months, but be aware that some other classes may not support REEF.
 - Required Textbook: Birney, Bonzalez, Oesper, *Observational Astronomy*, Second Edition. There will be readings and homework questions assigned from this book. This is available at the bookstore for \$52.50 (new) to \$35.00 (used) which is several dollars cheaper than Amazon.
 - Computer: You will need a computer to complete nearly all assignments. If you don't have one, you can use the department computer lab and also the Cline Library rents computers.
 - Required supplementary readings will be made available on BbLearn.
 - Calculator: A scientific calculator will be useful for in-class exams where web-enabled devices are not allowed. The Texas Instruments TI-30XA Solar (about \$16 on Amazon) requires no batteries and will last decades. There is a similar model at the NAU Bookstore for a bit more money. The Cline Library also rents these.
 - Paper and pencil.
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Class Outline: Below is an approximate outline of the topics covered by week. These will be adjusted based on the pre-class assessment survey and the pace of student learning. Also, there is the possibility of class cancellation in the event of adverse weather, terrorist threat, and/or pandemic. If either instructor deems travel conditions unsafe, we will cancel class and notify the class by email prior to 7:35am the morning of class. Anytime NAU is closed, this class will also be cancelled.

- Week 1 (Aug 27, 29): Introduction, By-Eye Astronomy, Archeoastronomy, Light, Celestial Sphere, Time

- Week 2 (Sep 3, 5): By-Eye Astronomy, Snell's Law, Celestial Sphere, Time, Spherical Triangles, Light, Luminosity, Charge-Coupled Devices
- Week 3 (Sep 10, 12): Luminosity, Optical Telescopes, Charge-Coupled Devices, Black-Body Radiation, Planck's Law, Wein's Law
- Week 4 (Sep 17, 19): Guest Speakers
- Week 5 (Sep 24, 26): Signal to Noise Ratio, Statistics, Optical Photometry, Astronomical Magnitudes, Colors, Effects of the Atmosphere, Rayleigh Scattering
- Week 6 (Oct 1, 3): Astrometry, Proper Motion, Precession, Effects of the Atmosphere, Effects of the Interstellar Medium
- Week 7 (Oct 8, 10): Catalogs, Spectrographs, Spectroscopy, Solar Astronomy, Review, **Exam Oct 10**
- Week 8 (Oct 15, 17): Exoplanet Detection / Radial Velocity, Binaries, Stellar Astronomy, Point Sources, Point-Spread Function
- Week 9 (Oct 22, 24): Galactic Astronomy, Extended Sources, Cosmic Rays, Adaptive Optics
- Week 10 (Oct 29, 31): Distance Ladder, Cosmology, Theoretical Astronomy, Gravitational Lenses
- Week 11 (Nov 5, 7): Planetary Astronomy, Occultations, Craters, Planning Observations
- Week 12 (Nov 12, 14): Infrared Astronomy, Mid-Infrared Astronomy, Meteoritics, Interplanetary Dust Particles, Airplane Astronomy
- Week 13 (Nov 19, 21): Dynamics; Balloon, Rocket and Space-Based Astronomy, Ultra-violet, X-Ray and Gamma-Ray Astronomy, Review, **Exam Nov 21**
- Week 14 (Nov 26): Time Domain Astronomy, Gravitational Waves (Nov 28 no class — Thanksgiving Holiday)
- Week 15 (Dec 3, 5): Review, AST 580 Presentations
- Final Exam (Tue Dec 10, **7:30am – 9:30am**)

Class Policies: Class policies are described below.

Lecture Attendance: You are expected to attend every Lecture. You may miss 3 Lectures over the semester without penalty (no excuse needed) if you notify either Dr. Trujillo or Dr. Trilling ahead of time. Institutional excuses do not count towards the 3 classes you can miss. We generally grant additional absences for research-related matters (conferences, etc.) provided we know in advance.

Lecture Homework Policy:

- For all homework, as in life, you may work together. However, understand that solving problems by yourself is a core skill in academic inquiry. The submitted homework you must create yourself. You must also reference other people that helped you with the homework. The reason for this is because in the real world, not attributing your sources does help a disservice at best and at worst is plagiarism, which is one of the greatest sins in academia.
 - Reading assignments with feedback: We will have reading assignments from the textbook, journal publications, and other sources. You will generally have to create some kind of feedback, which may be a written summary of the article or you may have to lead a discussion in class. The purpose of this is because studies show that if you write about or discuss an article (rather than just reading it), knowledge of the subject and retention is greatly increased.
 - Calculations: 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.
 - Writing assignments: Being able to communicate effectively in writing is one of the most important skills in the sciences. There will be writing assignments where not only the content but the clarity of your work will be assessed.
 - Late policy: you can turn in 3 Lecture Homework assignments in this course 3 days late (due on Sunday at 11:59pm) for full credit if you notify both instructors *prior* to the original deadline. No other excuse is needed. You cannot "bank" this time (turning in 1 assignment 9 days late) or "gift" your late assignment quota to others. The reason for this is that since we normally give you a week to do each assignment, and it takes us about a week to grade it after all assignments are turned in, a more lenient late policy delays 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.
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Exam Policy:

- In this class all exams and quizzes will be closed note and closed book. 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.
 - Exams are designed to test individual knowledge. However, there may be opportunities for some group work on tests, but these will be clearly announced. In the absence of such an announcement, working together on a test is considered cheating.
 - As in the homework, all work must be shown for full credit.
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Plagiarism and Cheating: Plagiarism is using someone else's work or ideas and passing them off as your own. It 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 / exam, regardless of who cheated off whom. Repeat offenses will be escalated to the Dean following the NAU Academic Integrity Policy.

E-learning Resources Policy: Some course work will take place electronically, including (but not limited to) out-of-class communication, presentation of reading materials, distribution of homework and virtual lectures. It is the responsibility of the student to check email and Bb Learn 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, software version mismatches, etc. Students are also strongly encouraged to back up all data.

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 some of the required class resources (textbook, i>clicker2) present a financial hardship to you, please see either instructor and we will try to find an accommodation.

Disability Resources: If disability accommodations would benefit you, please talk to us and/or the Disability Resource office at NAU. 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>.

COURSE TIME COMMITMENT

Pursuant to Arizona Board of Regents guidance (Academic Credit Policy 2-224), for every unit of credit, a student should expect, on average, to do a minimum of three hours of work per week, including but not limited to class time, preparation, homework, and studying.

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 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, or veteran status. Due to potentially unethical consequences, certain consensual amorous or sexual relationships between faculty and students are also prohibited. The Equity and Access Office (EAO) responds to complaints regarding discrimination and harassment that fall under NAU's Safe Working and Learning Environment (SWALE) policy. EAO also assists with religious accommodations. For additional information about SWALE 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 via the EAO website at <https://nau.edu/equity-and-access>.

TITLE IX

Title IX is the primary federal law that prohibits discrimination on the basis of sex or gender in educational programs or activities. Sex discrimination for this purpose includes sexual harassment, sexual assault or relationship violence, and stalking (including cyber-stalking). Title IX requires that universities appoint a "Title IX Coordinator" to monitor the institution's compliance with this important civil rights law. NAU's Title IX Coordinator is Pamela Heinonen, Director of the Equity and Access Office located in Old Main (building 10), Room 113, PO Box 4083, Flagstaff, AZ 86011. The Title IX Coordinator is available to meet with any student to discuss any Title IX issue or concern. You may contact the Title IX Coordinator by phone at 928-523-3312 (TTY: 928-523-1006),

by fax at 928-523-9977, or by email at pamela.heinonen@nau.edu. In furtherance of its Title IX obligations, NAU will promptly investigate and equitably resolve all reports of sex or gender-based discrimination, harassment, or sexual misconduct and will eliminate any hostile environment as defined by law. Additional important information about Title IX and related student resources, including how to request immediate help or confidential support following an act of sexual violence, is available at <http://nau.edu/equity-and-access/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), 928-523-6906 (TTY), 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, 2019