

Department of Physics and Astronomy
AST 580 Techniques in Observational Astronomy Syllabus

2019 Fall

4 Credit Units

Prerequisite: PHY 361

Coconvened with AST 401 and AST 401L

Updated December 2, 2019

Mode of Instruction:

AST 580 (Lecture)

- Meets Tuesdays and Thursdays 9:35 - 10:50am in Bldg. 19, Room 321.
- Instructor: Dr. Chad Trujillo Email: chad.trujillo@nau.edu
Office: Physical Sciences (#19) 312 Office phone: 523-6007
Office Hours: Tue/Thu 11am – noon (right after class), Wed 10am – 11:30am 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 Dr. Trujillo at <https://goo.gl/forms/BSvNSPSML7WXMzm22>.

AST 401L (Lab)

- Meets Wednesdays 2:20pm – 4:50pm in Bldg. 19, Room 232 and 7:00pm – 9:00pm at the Campus Observatory.
 - Instructor: Ed Anderson Email: Ed.Anderson@nau.edu
Office: Physical Science (#19) 323 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, and (4) have familiarity with the wide variety of astronomical techniques and astronomical technologies available to the modern professional astronomer.

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 1 mid-term exam and 1 final exam. Exams are being given because (1) it is an individual effort, which is 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 Thursday Oct 11, Monday Oct 29 and Wednesday November 7. There are also nights scheduled on the 31-inch NURO telescope on Anderson Mesa: September 13, 20, and 27 with any additional nights announced in class.

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.

- **Final Exam:** The final exam will take place on Tuesday Dec 11 **7:30am - 9:30am**. This will be worth 15% of your grade.
- **Mid-Term Exam:** There will be a mid-term exam on Thu October 25 (I will be out of town then). I will write the questions for the exam and it may cover any material that you have done a homework about (and received feedback on). This will be worth 10% of your grade.
- **Homework:** There will be 1 homework assigned each week of lecture except for the week before the mid-term 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%.
- **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. You will present your term paper in Lecture during the last weeks of the course. The Lab Reports, Term Paper and Presentation total 40% of your grade. The term paper is due in lab on Wednesday, December 5.
- **Extra Credit:** There is extra credit for attending the Physics and Astronomy 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.

Readings and Materials:

- i>clicker2 remote: **Bring this to every class.** Most of the students already have this from other classes. They are available at the NAU Bookstore for \$57.50 (new) to \$23.00 (rent, used). Also available on Amazon for \$50.16 (new, with Amazon Prime delivery). 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.
 - 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 \$15 on Amazon) requires no batteries and will last decades. There is a battery powered model IT-30XA at the NAU Bookstore or Amazon. 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 instructor jury duty, adverse weather, terrorist threat and/or pandemic. If I deem travel conditions unsafe, I 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 28 – 30): Introduction, By-Eye Astronomy, Archeoastronomy, Light, Celestial Sphere, Time
- Week 2 (Sep 4 – 6): By-Eye Astronomy, Snell's Law, Celestial Sphere, Time, Spherical Triangles, Light, Luminosity, Charge-Coupled Devices
- Week 3 (Sep 11 – 13): Luminosity, Optical Telescopes, Charge-Coupled Devices, Black-Body Radiation, Planck's Law, Wein's Law
- Week 4 (Sep 18 – 20): Signal to Noise Ratio, Statistics, Optical Photometry, Astronomical Magnitudes, Colors, Effects of the Atmosphere, Rayleigh Scattering, Astrometry
- Week 5 (Sep 25 – 27): Astrometry, Proper Motion, Precession, Effects of the Atmosphere, Effects of the Interstellar Medium, Adaptive Optics, Catalogs, Spectrographs, Spectroscopy

- Week 6 (Oct 2 – 4): Catalogs, Spectrographs, Spectroscopy, Solar Astronomy, Binaries, Exoplanet Detection / Radial Velocity
 - Week 7 (Oct 9 – 11): Binaries, Stellar Astronomy, Point Sources, Point-Spread Function
 - Week 8 (Oct 16 – 18): Galactic Astronomy, Extended Sources, Cosmic Rays, Review (No Homework)
 - Week 9 (Oct 23 – 25): Radio Astronomy (Deidre Hunter), Mid-Term Exam
 - Week 10 (Oct 30 – Nov 1): Distance Ladder, Cosmology, Theoretical Astronomy, Gravitational Lenses, Mid-Term Exam Discussion
 - Week 11 (Nov 6 – 8): Planetary Astronomy, Occultations, Craters
 - Week 12 (Nov 13 – 15): Meteoritics, Interplanetary Dust Particles, Airplane Astronomy, Infrared Astronomy, Mid-Infrared Astronomy
 - Week 13 (Nov 20): Dynamics; Balloon, Rocket and Space-Based Astronomy, Ultra-Violet, X-Ray and Gamma-Ray Astronomy (Nov 22 no class — Thanksgiving Holiday)
 - Week 14 (Nov 27 – 29): Time Domain Astronomy, Gravitational Waves, Review, AST 580 Presentations
 - Week 15 (Dec 4 – 6): Guest Lecture, Review, AST 580 Presentations
 - Final Exam (Tue Dec 11, 7:30am – 9:30am)
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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 Dr. Trujillo ahead of time. Institutional excuses do not count towards the 3 classes you can miss. I generally grant additional absences for research-related matters (conferences, etc.) provided I 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/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 someone else can 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 1 week late for full credit if you notify me *prior* to the deadline. No other excuse is needed. You cannot “bank” this time (turning in 1 assignment 3 weeks late) or “gift” your late assignment quota to others. That is because this could result in people falling too far behind in the class and also because it delays return of the other homeworks.
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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. Therefore no group work is allowed on tests.
 - 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.

Disability Resources: If disability accommodations would benefit you, please talk to me 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.

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 breach the peace, 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>.

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.

Updated 8/20/2018

Updated 3/29/17

Approved UGC – 2/12/14

Approved UCC – 1/28/14