NORTHERN ARIZONA UNIVERSITY

Department of Astronomy and Planetary Science

AST 190 Syllabus

Course:	AST 190: Exploring the Planets
Department:	Astronomy and Planetary Science
Pre/Co-requisite:	None
Term:	Fall 2024
Sections:	AST 190 - 001
Meeting time:	MoWeFr 12:40 - 1:30 PM
Mode of Instruction:	In Person
Meeting Location:	Bldg. 36 (Science and Health), Rm. 106
No. Course Credits:	3

Instructor:	Chris Wolfe
Pronouns:	he/him/his
e-mail:	cw997@nau.edu
Availability:	Typically responds to e-mail within 24 hours. If not, please email again!
Urgent matters:	Emails with “URGENT AST190” in the subject line will be responded to asap.
Office Location:	Bldg. 20 (Science Annex), Rm. 331 or Zoom
Office Hours:	MoWe 11:30 AM - 12:30 PM or by appointment

Readings and Materials

Primary “Textbook”:

Astronomy (OpenStax) - https://openstax.org/details/books/astronomy

Other Resources:

Exploring the Planets (Website) - http://explanet.info/

Readings identified in the schedule below by chapter and section numbers refer to the primary online textbook – OpenStax Astronomy. For some topics, the website under “other resources” provides information better suited to this course. In those cases, the relevant sections from that website are linked directly in the schedule. Students are always welcome to explore the other resources in more detail for all topics – seeing material presented in different ways helps the learning process. Additional readings may include a combination of chapters from other textbooks and possibly articles from the popular science literature and will be posted on the course Canvas website.

Course Description

In this course, we discuss the Solar System, as it exists today. As part of this discussion, we learn not only about the planetary bodies in the Solar System, but also about the technology and laws of physics used to access that information. We also practice critical thinking in the form of using observations and data of the Solar System as it exists today to extrapolate back in time to think about how it formed. This course provides students with knowledge about the natural world and the impact

of technology on exploring the natural world under the Science and Applied Science Distribution Block of the liberal studies program, and helps students develop the essential skill of critical thinking and hypothesis testing through various in-class active learning and homework assignments. Cross-listed with GLG 190. Letter grade only.

Course Objectives

Student Learning Outcomes (SLOs) contribute to the Liberal Studies Science and Applied Science Distribution Block (indicated by "SAS") and the essential skills of scientific inquiry (indicated by "SI"), critical thinking (indicated by "CT"), and quantitative reasoning ("QR"). Students who successfully complete this Liberal Studies course will:

(a) Understand and be able to explain in words and diagrams the structure of the Solar System, at least two hypotheses for its formation, which hypothesis is better supported by observations, and explain how this formation is expressed in the structure of the Solar System and its planetary bodies (SAS, SI, CT)

(b) Understand and be able to explain in words and diagrams the physical process by which the Sun generates heat, including at least two hypotheses for this process and explaining which hypothesis is better supported by observations (SAS, SI).

(c) Understand and be able to explain the basic physical and geologic processes that operate on solid-surface planetary bodies and how they operate differently on different bodies (SAS). On the basis of observations in spacecraft data, formulate hypotheses for planetary landscapes and test those hypotheses with an additional dataset. Interpret the formation and evolution of specific planetary landscapes (SI).

(d) Understand and be able to explain the physical laws and technology used in planetary exploration (SAS, QR).

(e) Understand, be able to explain, and apply basic quantitative reasoning, accepted theories or laws, and analytical methods used in planetary exploration for testing hypotheses, including identifying the most appropriate approach (SAS, SI, CT, QR).

(f) Demonstrate knowledge of the dynamism of planetary science and on-going discoveries in this field, including how new or recent data are used to test hypotheses and whether the conclusion for the data is warranted (SAS, SI, CT).

This course also supports the achievement of Department of Astronomy and Planetary Science learning outcomes as listed at https://nau.edu/astronomy-and-planetary-science/bs-astronomy/ which include:

- Students will be able to apply the laws of physics in order to understand the:
    - Origin and evolution of the Solar System and other planetary systems.
    - Origin and evolution of stars.
- Students will be able to apply mathematical tools such as elementary algebra, geometry, trigonometry, to solve physics and astronomy problems.
- Students will develop problem-solving capacities. In particular, a student will be able to:
    - Ascertain the known and unknown aspects of a problem.
    - Describe the fundamental physical principles in the problem.

- Students will be able to clearly communicate and defend their work in verbal, written, and visual formats to non-scientific audiences.

Lastly, this course provides a number of career-ready competencies (CRCs) - skills that will broadly prepare you for success in the workplace and lifelong career management[1]. CRCs in this course include:

- Career & Self-development: Display curiosity; seek out opportunities to learn.
- Communication: exchange information and perspectives in a clear manner that others can effectively understand.
- Critical Thinking: make judgments using sound and inclusive reasoning.
- Professionalism: Act equitably with integrity and accountability; be present and prepared.
- Teamwork: Listen carefully to others, taking time to understand, ask appropriate questions without interrupting.
- Technology: use technology appropriate to complete relevant tasks.

Assignments

Quizzes

Lecture time will primarily focus on integrating newly acquired knowledge. Students are responsible for their own initial learning through reading the textbook assignments and PowerPoint slides. Research shows that for best comprehension, readings should be completed before class. Read actively! Take notes, make an outline, and note anything you don't understand so you can ask about it.

- *No make-up reading quizzes will be offered.*
- *Lowest 2 reading quiz grades will be dropped.*

In-Class Discussions

Throughout the semester, the class will split up into smaller sections for group discussions of material covered in class. Discussions are facilitated through worksheets that each group will fill out and turn in. These worksheets will be graded. Only students present for the discussion will receive credit for the group work.

- *No make-up in-class discussions will be offered.*
- *Lowest 2 in-class discussion grades will be dropped.*

Current Events Essays

Planetary science is happening now! Each Monday, we will discuss current events in planetary science. You are required to upload and submit a summary of a current event in planetary science via the Canvas website. This topic will most likely be a news event from the past week, but could also be a summary of new results from a currently active mission. The summary must be written in your words, include an explanation for why it is relevant to planetary science, and include the primary source (e.g., website URL). Images or plots from web pages may accompany your summary, but the summary itself must be in your own words.

- *No make-ups will be offered for current events.*
- *Lowest 2 Current Event grades will be dropped.*

Mid-term Exams

Three mid-term exams on the lecture and current events materials will provide an opportunity to demonstrate individual understanding of the material. These exams may include: objective,

fill-in-the-blank questions; drawing and/or labeling diagrams; calculations and/or mathematical reasoning; articulating in short answer questions reasonable means for testing given hypotheses; and matching of planetary missions with their technology, data types and approach for the data analyses, and discoveries.

- *If you miss an exam due to an unexpected emergency, get in touch with me right away and we will discuss whether an accommodation is appropriate. No make up exams will be offered after graded exams are turned back (usually within a week of the exam). If you know beforehand that you'll miss an exam, let me know before the exam and see the note below about Institutional Excuses.*

Final Exam

The final exam will synthesize course material, pulling together everything covered during the semester. The final exam may include questions from the three ~monthly exams, including: objective, fill-in-the-blank questions; drawing and / or labeling diagrams; calculations and/or mathematical reasoning; articulating in short answer questions reasonable means for testing given hypotheses; and matching of planetary missions with their technology, data types and approach for the data analyses, and discoveries.

- *If you miss an exam due to an unexpected emergency, get in touch with me right away and we will discuss whether an accommodation is appropriate. No make up exams will be offered after graded exams are turned back (usually within a week of the exam). If you know beforehand that you'll miss an exam, let me know before the exam and see the note below about Institutional Excuses.*

Attendance

Attendance will not be taken in lecture. However, students who are frequently absent will do poorly because 1) they have less opportunity to hear/discuss material, 2) they will miss in-class discussions, which are graded, 3) they will miss material that is not covered in the book, for example, about on-going missions and new discoveries, material that may well appear on quizzes or exams, and 4) current events must be turned in during class, in person.

Grading System

Your total grade is weighted as follows:

Quizzes	15%
In-class Discussions	20%
Current Events Essays	20%
Mid-term Exams	30%
Final Exam	15%
Total	**100%**

Grading Scale

89.5 - 100% → A
79.5 - 89.49% → B
69.5 - 79.49% → C
59.5 - 69.49% → D
≤ 59.49% → F

Extra Credit

I am more than happy to reward excellence, creativity, and extra work. I therefore encourage everyone to go beyond what we learn in lecture, particularly if some topic really excites you. To earn extra credit:

- Develop an idea that would:
  - Enhance your understanding of the material
  - Contribute to the learning environment of the class.
- Then discuss it with me and we will decide if it is appropriate and negotiate how much extra credit the project will be worth (typically 1% on the final grade for a standard project).

Limits: Each person can earn no more than 8% total extra credit for the semester. Only one extra credit project per week per person is allowed (i.e., you cannot wait until the last week of classes and turn in multiple projects). The last day of classes (Dec 6) is the last possible time to turn in any extra credit – absolutely no exceptions.

Potential extra credit ideas: Original artwork, poetry, prose, engineering design, etc., inspired by something related to planetary science. One page (single spaced, 12 pt font) summary of one of the lectures from an approved planetary science lecture series (e.g., http://www.seti.org/talks) or any relevant talk at NAU. An innovative presentation to explain some topic from lecture. Group projects will be considered.

Missed Assignments and Make-ups

NAU significantly updated the Institutional Excuse policy this year. This policy governs when and how to get approval for missing class due to extended illness, military service, religious observances, bereavement, and other life events. Please see the following website for information and forms: https://in.nau.edu/academic-affairs/institutional-excuses/

The Dean of Students is an excellent resource for students. Their website on missing classes can be very helpful for navigating what steps to take if you have to miss classes: https://in.nau.edu/dean-of-students/absence/

Schedule

Below is a tentative schedule for the class.

Week	Day (Item)	Lecture Topic	Reading	Assignment
1	M (Lecture) 8/26	Introduction and Solar System Overview	Chapter 7.1 http://explanet.info/Chapter01.htm (all)	
	W (Lecture) 8/28	Syllabus and the Scientific Method	Syllabus https://undsci.berkeley.edu/article/intro_01	Syllabus Quiz (Quiz 0)
	F (Discussion) 8/30	Scientific Method Discussion	Same as previous lecture	Discussion 1
2	M	No Class - Labor Day		

	9/2			
	W (Lecture) 9/4	Celestial Motions	Chapter 1 (1.6 - 1.9) Chapter 2 (2.1) Chapter 4	Quiz 1
	F (Discussion) 9/6	Celestial Motions Discussion	Same as previous lecture	Discussion 2
3	M (Lecture) 9/9	Gravity	Chapter 3	Current Event Essay 1
	W (Lecture) 9/11	Observing Remotely (Light, Telescopes, Spacecraft; Atoms & Spectra)	Chapter 5 Chapter 6	Quiz 2
	F (Discussion) 9/13	Observing Remotely Discussion	Same as previous lecture	Discussion 3
4	M (Lecture) 9/16	Understanding Matter	Morrison & Owen, Chapter 3 (Canvas) http://explanet.info/Chapter02.htm (all)	Current Event Essay 2
	W (Lecture) 9/18	Formation of Planetary Systems	Chapter 7 (7.2 - 7.4) Chapter 14 (14.3, 14.4)	Quiz 3
	F (Discussion) 9/20	Formation of Planetary Systems Discussion	Same as previous two lectures	Discussion 4
5	M (Lecture) 9/23	Sun	Chapter 15 (15.1 - 15.3) Chapter 16 (16.2, 16.3)	
	W (Exam) 9/25	**Exam 1**		
	F (Lecture) 9/27	Earth	Chapter 8 (8.1 - 8.3) http://explanet.info/Chapter08.htm (all)	
6	M (Lecture) 9/30	Earth	Same as previous lecture	Current Event Essay 3

	W (Lecture) 10/2	Impacts	Chapter 9.3, Chapter 8.5	Quiz 4
	F (Discussion) 10/4	Earth Discussion	Same as previous lecture	Discussion 5
7	M (Lecture) 10/7	Meteorites/Asteroids	Chapter 14 (14.1, 14.2) Chapter 13 (13.1, 13.2)	Current Event Essay 4
	W (Lecture) 10/9	Asteroids/Comets	Chapter 13 (all)	Quiz 5
	F (Discussion) 10/11	Meteorites, Asteroids, and Comets Discussion	Same as previous two lectures	Discussion 6
8	M (Lecture) 10/14	The Moon	Chapter 9 (9.1 - 9.4) https://explanet.info/Chapter04.htm (4.2, 4.3, 4.8, 4.9)	Current Event Essay 5
	W (Lecture) 10/16	Mercury	Chapter 9 (9.5) https://explanet.info/Chapter05.htm (5.0 - 5.8)	Quiz 6
	F (Discussion) 10/18	Moon & Mercury Discussion	Same as previous two lectures	Discussion 7
9	M (Lecture) 10/21	Venus	Chapter 10 (10.1 - 10.3, 10.6) https://explanet.info/Chapter07.htm (all)	
	W (Exam) 10/23	**Exam 2**		
	F (Lecture) 10/25	Mars	Chapter 10 (10.1, 10.4 - 10.6)	
10	M (Lecture) 10/28	Mars	https://explanet.info/Chapter06.htm (6.0 - 6.8, 6.10, 6.11)	Current Event Essay 6
	W (Lecture) 10/30	Overview of Outer Solar System & Giant Planets	Chapter 11 (all)	Quiz 7

	F (Discussion) 11/1	Mars Discussion	Same as previous two lectures	Discussion 8
11	M (Lecture) 11/4	Jupiter	Chapter 12 (12.1, 12.2, 12.5)	Current Event Essay 7
	W (Lecture) 11/6	Jupiter's Moons	https://explanet.info/Chapter09.htm (all)	Quiz 8
	F (Discussion) 11/8	Jupiter and Jupiter's Moons Discussion		Discussion 9
12	M 11/11	No Class - Veterans Day		
	W (Lecture) 11/13	Saturn	https://explanet.info/Chapter10.htm (10.0 - 10.4)	Current Event Essay 8
	F (Lecture) 11/15	Saturn's Moons	https://explanet.info/Chapter10.htm (10.5)	Quiz 9
13	M (Discussion) 11/18	Uranus	https://explanet.info/Chapter11.htm (11.0 - 11.5)	
	W (Exam) 11/20	**Exam 3**		
	F 11/22	Neptune	https://explanet.info/Chapter12.htm (12.0 - 12.5)	
14	M (Lecture) 11/25	Kuiper Belt and Dwarf Planets (including Pluto)	Chapter 12.4 https://explanet.info/Chapter13.htm (13.0 - 13.3)	Current Event Essay 9
	W (Lecture) 11/27	Topic of your choice! 🙂		
	F 11/29	No Class - Thanksgiving Break		
15	M (Lecture) 12/2	Exoplanets	Chapter 21 (21.3 - 21.6)	Current Event Essay 10
	W (Lecture) 12/4	Life in the Universe	Chapter 30 (all)	Quiz 10

	F (Discussion) 12/6	Exoplanets and Life Discussion	Same as previous two lectures	Discussion 10

Final Exam - Monday, December 9 (12:30 - 2:30 PM)

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 (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 conductive 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, or veteran status. Due to potentially unethical consequences, 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 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 Elyce C. Morris. 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 928-523-3515, by fax at 928-523-0640, or by email at elyce.morris@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 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), 928-523-6906 (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 23, 2021