

# AST 390: Astrophysics: The Solar System

## College of the Environment, Forestry, & Natural Sciences



College of the  
Environment, Forestry,  
and Natural Sciences

<b>Department:</b>	Astronomy and Planetary Science
<b>Semester:</b>	Spring 2025
<b>Prerequisites:</b>	AST 280: Introduction to Astrophysics PHY 263: University Physics III
<b>Location:</b>	Science & Health (SHB, Bldg. #36), Rm. 433
<b>Meeting Time:</b>	Mondays & Wednesdays, 11:10 am – 12:20 pm (3 credit hours)
<b>Instructor:</b>	Dr. Mark Salvatore, mark.salvatore@nau.edu, (928) 523-0324
<b>Office Location:</b>	225C Physical Sciences Bldg. (second floor, northwest corner)
<b>Office Hours:</b>	Tuesdays & Thursdays, 2:00 pm - 3:00 pm
<b>Undergraduate Grader:</b>	Hunter Brooks (hcb98@nau.edu)

### Course Purpose & Description

This course is a rigorous and multidisciplinary introduction to the physics that govern solar system processes. These include the concepts of classical mechanics, atmospheric and fluid dynamics, geophysics, and other geologic and astronomical mechanisms by which planets evolve over time. While this class focuses primarily on our own solar system (as that is where nearly all of our solar system-specific information is derived), we will also discuss application to other planetary systems.

The class first starts with a recap of celestial mechanics and the fundamental physics behind the formation and early evolution of the solar system. This includes the motion of planetary bodies, the initial collapse of planetary nebulae, and the principles that govern tidal forces. This then sets the stage for discussing the processes that govern the evolution of planetary bodies themselves, starting with the deep interior, working our way to the surface, and then eventually through their atmospheres. These processes include seismicity, volcanism, thermophysical properties of planetary surfaces, and the drivers of atmospheric circulation. Throughout the class, students will be introduced to different bodies in our solar system and how the principles that we learn in class specifically relate to their formation and evolution.

Letter grade only.

### Course Objectives & Learning Outcomes

This course has several objectives and learning outcomes that will be covered during the course and assessed through in-class assignments, homework assignments, and exams. By the end of the semester, students will be able to:

1. Apply concepts from physics, astronomy, chemistry, and geology to solve problems in astronomy and planetary science (**CT**);
2. Describe how planetary interiors, surfaces, atmospheres, and magnetospheres evolve and interact to produce the features seen today on solar system bodies (**Comm, CT**);
3. Describe the structure of the solar system and the major characteristics of terrestrial planets, giant planets, dwarf planets, and small solar system bodies (**Comm, CT**);
4. Describe the techniques used to detect extrasolar planetary systems (**CT, Tech**); and
5. Gain enough confidence in your understanding of these topics to read and comprehend professional papers in journals such as *Science*, *Nature*, the *Journal of Geophysical Research*, and *Earth and Planetary Science Letters* (**C&SD, Comm, CT, Tw**).

## **Career Readiness Skills**

In every class you take at NAU, you learn professional skills that can support your future career. There are a number of ways that this course can help you meet and excel in your future career. Below is a list of in-demand skills from the National Association of Colleges and Employers (NACE) you could earn and practice in this class. Competencies relevant to each of the course learning objectives and assignment categories can be found in **orange** throughout this syllabus, and include:

**Career & Self-Development (C&SD):** Proactively develop oneself and one's career through continual personal and professional learning, awareness of one's strengths and weaknesses, navigation of career opportunities, and networking to build relationships within and without one's organization.

**Communication (Comm):** Clearly and effectively exchange information, ideas, facts, and perspectives with persons inside and outside of an organization.

**Critical Thinking (CT):** Identify and respond to needs based upon an understanding of situational context and logical analysis of relevant information.

**Equity & Inclusion (E&I):** Demonstrate the awareness, attitude, knowledge, and skills required to equitably engage and include people from different local and global cultures. Engage in anti-racist practices that actively challenge the systems, structures, and policies of racism.

**Leadership (L):** Recognize and capitalize on personal and team strengths to achieve organizational goals.

**Professionalism (P):** Knowing work environments differ greatly, understand and demonstrate effective work habits, and act in the interest of the larger community and workplace.

**Teamwork (Tw):** Build and maintain collaborative relationships to work effectively towards common goals, while appreciating diverse viewpoints and shared responsibilities.

**Technology (Tech):** Understand and leverage technologies ethically to enhance efficiencies, complete tasks, and accomplish goals.

## **Assessment**

Students will be assessed on the above objectives through a series of in-class assignments, homework, and examinations. The modes of assessment and how they relate to the content of this course are discussed below.

**In-Class Assignments:** In-class assignments and activities test student retention. These consist of short individual and group assignments, discussion prompts, brief reflections, etc. (**C&SD, CT, Tw**)

**Homework Assignments:** Homework assignments are designed to strengthen your understanding of lecture materials and to prepare for examinations. Late assignments will be accepted up to 24 hours after the due date for a 30% point deduction and will not be accepted beyond 24 hours late without prior approval from the instructor. You may work together on homework assignments, but you must submit your own assignment and both your work and your responses must reflect your personal effort. (**C&SD, Comm, CT, L, P, Tw**)

**Exams:** There will be one midterm exam and one cumulative final exam. All exams will consist of short-answer written and fundamental calculation questions similar to those completed in the homework and in-class assignments. **No make-up exams will be offered without prior approval!** (**C&SD, CT**)

**Disposition & Engagement:** An important part of the learning process revolves around your attendance, participation, and engagement both during lecture and outside of class. Ask questions, attend office hours, and come to lectures prepared to learn. Interruptions and inappropriate behavior during class will not be tolerated as it is disrespectful to others and to the academic learning environment. Your professionalism and engagement in the class are critical components of your success. By default, your "disposition & engagement" grade will reflect your graded performance in the class. If you are disruptive, unprepared, or otherwise disengaged from the class, your grade will suffer; if you are engaged, prepared, and taking ownership of your own learning, then your grade will improve. (**Comm, CT, P**)

**Grading System:** The breakdown of points is as follows, and any changes to the class scoring rubric will be discussed with the class prior to implementation:

<i>In-Class Exercises &amp; Questions</i>	<i>15%</i>	<i>Final Exam</i>	<i>20%</i>
<i>Homework Assignments</i>	<i>50%</i>	<i>Disposition &amp; Engagement</i>	<i>5%</i>
<i>Midterm Exam</i>	<i>10%</i>	<b><i>TOTAL</i></b>	<b><i>100%</i></b>

Your course grade will be assigned based on the weighted average of your assignments using the following scale:

**A:**  $\geq 90\%$

**B:**  $80\% - 89.9\%$

**C:**  $70\% - 79.9\%$

**D:**  $60\% - 69.9\%$

**F:**  $< 60\%$

### **Required Materials**

Barlow, N. (2020), [Solar System Astrophysics](#). *Unpublished*. **Available for free!**

### **Class, Departmental, & University Policies**

- Please disclose any disabilities or special requirements to the NAU Disabilities Resources Office, who will contact me privately regarding any accommodations. I want to make sure that every student has an equal opportunity to learn and succeed.
- Don't cheat. You're paying good money to learn, and if you don't appreciate the knowledge gained right now, you will in the future. *If you feel like you need to cheat in order to succeed in this class, come talk to the professor to establish a more sustainable plan for succeeding.*
- While attendance in class is not mandatory, remember that you have a fairly significant in-class participation grade.
- As a courtesy to the instructor and to your fellow students, please come to class on time. Students who arrive late for exams will not be given extra time. In-class points missed due to tardiness cannot be made up.
- Please silence all cellular devices during class. Please refrain from any other "electronic distractions" (e.g., text messaging, browsing social media) during class. If you are anticipating cellular disruptions during class for any personal or professional reasons, please notify the professor prior to class.
- Class disruptions are defined as activities that distract the instructor or other students from delivering or learning the course materials. Such activities include talking or whispering during class, habitual tardiness or leaving class early, or electronic distractions. Disruptive students will be asked to leave the classroom, and repeat offenders may be withdrawn from the class.
- Neither audio nor video recording will be permitted except under special circumstances prescribed by the NAU Disability Resources Office or discussed with the professor prior to class.
- **Additional departmental and university policies can be found at [www.physics.nau.edu/SYLLABI/POLICY/policy.html](http://www.physics.nau.edu/SYLLABI/POLICY/policy.html).** This course falls under all departmental and university policies unless otherwise stated in this document.

## Course Schedule

The following course schedule includes the weekly lecture topics, dates of examinations, due dates for homework, and the required reading materials. This schedule is subject to change, and any significant changes will be discussed with the class prior to their implementation.

Week	Week of	Topic	Reading	Assignment*
1#	01/13/2025	Celestial Mechanics	Ch. 1	
2	01/20/2025	Physical Processes within the Solar System	Ch. 1	HW #1 (Due 01/24)
3	01/27/2025	The Structure of Solar Systems	Ch. 2	
4	02/03/2025	Planetary Interiors	Ch. 3	HW #2 (Due 02/07)
5	02/10/2025	Interiors (cont.)	Ch. 3	
6	02/17/2025	Thermophysics	<i>Supplemental</i>	HW #3 (Due 02/21)
7	02/24/2025	Atmospheres	Ch. 4	
8	03/03/2025	Surfaces	Ch. 4	HW #4 (Due 03/07)
9	03/10/2025	Spring Break		
10	03/17/2025	Surfaces (cont.)	Ch. 4	
11	03/24/2025	Small Bodies	Ch. 5	<b>Exam #1 (03/24)</b>
12	03/31/2025	Small Bodies (cont.)	Ch. 5	HW #5 (Due 04/04)
13	04/07/2025	Terrestrial Planets	Ch. 6	
14	04/14/2025	Terrestrial Planets (cont.)	Ch. 6	HW #6 (Due 04/18)
15	04/21/2025	Outer Planets	Ch. 7	
16	04/28/2025	Outer Planets (cont.)	Ch. 8	HW #7 (Due 05/02)
Finals Week		Final Exam <b>TBD</b>		

\*All homework is due at the end of that specific work week (Friday at **11:59pm MST**).

#Dr. Salvatore will be out of the country for the first week of the semester. More details to come!

## Submitting Assignments

Assignments may be submitted either in-person to Dr. Salvatore (or Hunter Brooks), or by uploading a copy of the completed assignment to the following [Google Form](#). If you are having trouble with the link, please use the following URL: <https://tinyurl.com/mu3ym5ct>

## Academic Deadlines

- 01/23/2025 Last day to drop/delete without a "W"
- 01/23/2025 Last day for 100% refund
- ~Mid-March Last day to withdraw from individual courses [*check date with your advisor!*]
- ~Late-April Last day to withdraw from all courses in a session [*check date with your advisor!*]
- 05/02/2025 Last day to withdraw without a petition

# COVID-19 Requirements and Information

Additional information about the University's response to COVID-19 is available from the **Jacks are Back!** web page located at <https://nau.edu/jacks-are-back>.

## 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://www9.nau.edu/policies/Client/Details/1443?wholsLooking=Students&pertainsTo=All>

### ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) technologies bring both opportunities and challenges. Ensuring honesty in academic work creates a culture of integrity and expectations of ethical behavior. The use of these technologies can depend on the instructional setting, varying by faculty member, program, course, and assignment. Please refer to course policies, any additional course-specific guidelines in the syllabus, or communicate with the instructor to understand expectations. NAU recognizes the role that these technologies will play in the current and future careers of our graduates and expects students to practice responsible and ethical use of AI technologies to assist with learning within the confines of course policies.

### 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. To report a concern related to possible unlawful discrimination or harassment or to request a time to meet, please use the [Report an Issue Form](#). To file a complaint, please submit the online [Complaint Form](#). EAO also assists with religious accommodations. To request a religious accommodation, please use the [Religious Accommodation Request Intake Form](#). EAO additionally provides access to lactation spaces, and please use to the [Lactation Space Request Form](#) to request use of a location. For additional information about nondiscrimination or anti-harassment, contact EAO at [EquityandAccess@nau.edu](mailto:EquityandAccess@nau.edu), or visit the EAO website at <https://nau.edu/equity-and-access>. The EAO is located in Old Main on the first floor.

## **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 employees, and covered guests.

One may direct inquiries concerning the application of Title IX to either or both the university Title IX Coordinator or the U.S. Department of Education, Assistant Secretary, Office of Civil Rights. You may contact NAU's Title IX Coordinator at [titleix@nau.edu](mailto:titleix@nau.edu) or by phone at 928-523-5434. In furtherance of its Title IX obligations, NAU promptly will investigate or equitably resolve all reports of sex/gender-based discrimination, harassment, or sexual misconduct and will eliminate any hostile environment as defined by law. To submit a report, please use the [File a Report Form](#). 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](#). ORSM also facilitates reasonable modifications for pregnant or parenting individuals. Additional important information and related resources, including how to request help or confidential support following conduct covered by the Sexual Misconduct Policy, is available on the [ORSM web site](#), and you also may contact the office at [titleix@nau.edu](mailto:titleix@nau.edu). The ORSM is located in Gammage on the third floor.

## **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](mailto: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](mailto: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, Scott Pryor, who can be reached at [scott.pryor@nau.edu](mailto:scott.pryor@nau.edu) or 928-523-5927. 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 5, 2024