SYLLABUS for AST/GLG 190 – The Planets
Fall 2021 - MWF 11:30 am – 12:20 pm

College of the Environment, Forestry, and Natural Sciences
Department of Astronomy and Planetary Science
AST/GLG 190: The Planets, 3 credits
Fall, 2021
Meeting time, days, and location:

- MWF 11:30 am – 12:20pm
- Cline Library 102
  - all M lectures, selected W and F lectures, and Exams
- Cline Library 249 and Health and Learning Center 3113
  - W and F discussions will be held in these rooms. The room will depend on the Group number assigned to each student
- See the course schedule below for when discussion will occur (highlighted in gold)

Course Pre-Requisite(s): none
Mode of Instruction: Face-to-face and some pre-recorded lectures
Primary Textbook: **https://openstax.org/details/books/astronomy**

Instructor: Prof. Joshua Emery
Office: Physical Science (Bldg 19), Room 323/324 ***[Temporarily 319 at start of semester]***
Office Phone: 928-523-6495 (landline - no texting capability)
Office hours (*times I'm available to help*): M and T 2-3pm, or by appointment
Email: joshua.emery@nau.edu

Course Purpose:

Advancing an understanding of the occupants of our Solar Systems is a key educational goal of the Department of Astronomy and Planetary Science (APS). AST/GLG190 provides a foundation for that understanding by introducing the study of planetary science, including the exploration of planetary landscapes and how they formed, as well as the technology that humankind has used to explore these worlds and develop this understanding. The course is required for APS majors pursing an emphasis in Planetary Science and is an elective for other major and minors. Students will:

- Become familiar with what we know (and don't know) about the planets, satellites, and other objects in the Solar System, particularly with respect to their geology
- Learn how different geologic processes operate on different bodies in the Solar System
- Develop critical thinking skills, learn about the scientific method
- See if a major in astronomy is for you!

Liberal Studies: AST/GLG190 is approved as a Liberal Studies course under the Science and Applied Science Distribution Block. The Liberal Studies program is designed to provide a breadth of understanding to complement the in-depth studies of any particular major. Courses in the Science and Applied Science distribution block enhance students' understanding of the nature and the use of technology in exploring nature. The three essential skills that will be practiced in this course are: i) scientific inquiry, the skills of formulating hypotheses on the basis of observations, obtaining and analyzing data to test hypotheses, and explaining phenomena by means of accepted principles, theories, or laws; ii) critical thinking, the skills – particularly as applied to one's own work – of articulating the meaning of statement, judging the truth of a statement while keeping in mind possible biases, and determining whether a conclusion is warranted by the evidence provided; and iii) quantitative reasoning, the application of numerical, visual or symbolic reasoning for the purposes of drawing inferences, understanding phenomena or making predictions.

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Course Student Learning Outcomes:

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:

- SLO 1. 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).
- SLO 2. 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).
- SLO 3. 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).
- SLO 4. Understand and be able to explain the physical laws and technology used in planetary exploration (SAS, QR).
- SLO 5. 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).
- SLO 6: 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

Assignments/Assessments of Course Student Learning Outcomes (grading weights):

Assignments / assessments are designed to support the accomplishment of Course Student Learning Outcomes, and will be in the form of i) in-class discussions, ii) online quizzes, iii) current events essays, and iv) four exams.

i) Quizzes (15%): [SLOs 1-4]
Lecture time will be focused on integrating the new information gained. Students are responsible for their own initial learning through reading the textbook assignments and powerpoint slides. Pedagogy 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.

To encourage reading, online quizzes will be administered via BBLearn each week.
No make-up reading quizzes will be offered.
Lowest reading quiz grade will be dropped.

ii) In-class discussions (20%): [SLOs 1-5, SI, CT, QR]

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 in-class discussion grade will be dropped.

iii) Current events essays (20%): [SLO 6, SI, CT]

Planetary science is happening now! Each Monday, we will discuss current events in planetary science. You are required to bring to class and turn in a summary of a current event in planetary science. 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 printouts of 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 CE grade will be dropped.

iv) Mid-term Exams (30%,): [SLOs 1-6; SI, QR]

Three ~monthly 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.

No make-up exam will be offered unless i) you missed the exam due to a true and serious emergency, ii) you present documentation of this emergency to the Dean of Students https://in.nau.edu/dean-of-students/nau-sos/ and ask them to notify me, and iii) I receive this notification before the next class.

v) Final exam (15%): [SLOs 1-6, SI, QR]

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.

No make-up final exam will be offered unless i) you missed the exam due to a true and serious emergency, ii) you present documentation of this emergency to the Dean of Students https://in.nau.edu/dean-of-students/nau-sos/ and ask them to notify me, and iii) I receive this notification by the next day.

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.

Course grade summary:

Your final grade will be determined as follows:

Three exams (10% each):	30%	
Final:	15%	
Quizzes:	15%	[lowest quiz grades will be dropped]
Discussions:	20%	[lowest discussion grade will be dropped]
Current Events:	20%	[lowest CE grade will be dropped]
Total:	100%	

Grading Scale:

90-100%	→	A
80-89.5%	→	B
70-79.5%	→	C
60-69.5%	→	D
≤ 59.9%	→	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: 1) enhance your understanding of the material and 2) 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 3) is the last possible time to turn in any extra credit – absolutely no exceptions.**

Potential project 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.

Office Hours: These hours (listed at the top of the syllabus) are times that I will be in my office prepared to talk with students and answer questions about the class. Feel free to drop by during office hours, or e-mail to make an appointment outside of these hours.

Readings and Materials:

Primary "Textbook": Astronomy (OpenStax) – https://openstax.org/details/books/astronomy
Other Resources: https://nineplanets.org/
https://solarsystem.nasa.gov/solar-system/our-solar-system/overview/
http://explanet.info/

Primary readings identified in the schedule below by chapter and section numbers refer to the primary online textbook – OpenStax Astronomy. For some topics, the "other resources" provide information better suited to this course. In those cases, the relevant sections from those resources are linked directly in the schedule. Students are always welcome to explore the other resources in more detail for all topic – 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 Bblearn website.

Class Policies.

Behavioral Standards of Conduct: Please silence cell phones before class. Laptops, tablets, and/or phones may be used for class purposes (e.g., taking notes) *only*. Using devices for non-class purposes is distracting to students around you, and creating such disruption to the class learning environment is selfish and unacceptable. If devices are used in ways that are disruptive, the privilege of using them will be revoked (i.e., they will no longer be allowed) for those abusing the privilege.

Extensive research demonstrates that *the human brain cannot multi-task.* Our focus simply shifts back and forth from one task to the other, a switching process that takes time, and so we are less efficient at both tasks, and our brains get worse at switching the more we try to do it. In other words, it is not physically possible to both pay attention to lecture and do something else on your device. Your learning and understanding will be diminished.

The information contained in this syllabus, other than this course's grade and attendance policies, may be subject to change with reasonable advance notice.

How To Do Well in this Course

1. BEFORE class: read assigned chapters, so you can ask questions about anything confusing.
2. IN class: pay attention and take good notes.
3. WEEKLY: meet in a study group with people who will actually study before you get together.
4. BEFORE EXAMS: review your notes, study the images in each chapter, and answer the review questions at the end of each chapter as well as the sample exam questions I will provide.
5. *Ask questions*! Ask in or before/after class, email me, ask your lab TA, ask the tutor, make an appointment for my office hours, ask your classmates.
6. Try to understand concepts and processes – don't just memorize definitions (although you'll need to have a general idea of what words mean for exams).

Advice from former students:

On reading the textbook and preparing for lecture: "I read the text prior to lecture and take notes during lecture on a hard copy of the power point presentation."

On attending lectures: "GO TO CLASS! Attending class helps me immensely."

"It's not even taking notes a lot of times, it is more just sitting there and actively paying attention to what you are saying. I believe it helps to hear someone say it."

On keeping up with the course: "You can't learn it all the night before. I split up all my classes so I study something everyday (except Friday is my day off)."

On studying for exams: "I reviewed my highlighted and marked-up copies of lecture slides"

"When test time comes you have to dedicate a good amount of time to studying. I study two separate days. You can't expect to learn it all at once. There is too much information and you will forget it all. I found having a study partner helps. If you can explain it and teach it to someone else then you have mastered it. Plus, it can help you with tough concepts."

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COURSE SCHEDULE

Week	Day, Item, Location	Lecture Topics	Text Readings*
8/23	M Lecture (102)	Introduction & The Solar System	*Chapter 7.1* *The rest of Chapter 7*** *[http://explanet.info/Chapter01.htm]***
	W Lecture (102)	Syllabus & Scientific Method	Syllabus, *[https://undsci.berkeley.edu/article/intro_01]* **
	F discuss (102)	*Scientific Method Discussion*	*same as previous class*
8/30	M Lecture (102)	Here and Now Celestial Motions	Chapter 1 (1.6 – 1.9) Chapter 2 (2.1) Chapter 4
	Online Lecture	Gravity	Chapter 3
	W, F discussion (249 & 3113)	*Celestial Motions & Gravity discussion*	*same as previous two lectures*
9/6	M	***No Class – Labor Day***	
	Online lecture	Observing Remotely (Light, Telescopes, & Spacecraft; Atoms & Spectra)	Chapter 5 (all) Chapter 6 (all)
	W, F discussion (249 & 3113)	*Observing Remotely discussion*	*same as previous lecture*
9/13	M Lecture (102)	Understanding Matter	Morrison & Owen, Chapter 3 (BB site) *[http://explanet.info/Chapter02.htm]***
	Online Lecture	Formation of Planetary Systems	Chapter 7.4 Chapter 14 (14.3, 14.4)
	W, F discussion (249 & 3113)	*Formation of Planetary Systems discussion*	*same as previous two lectures*
9/20	M Lecture (102)	The Sun	Chapter 15 (15.1) (*15.2**,*15.3**, 15.4***) Chapter 16 (16.2) (16.1**, 16.3**, 16.4**)
	W Exam (102)	**EXAM #1**	
	F Lecture (102)	Earth	Chapter 8 (8.1–8.3) (8.4**) http://explanet.info/Chapter08.htm
9/27	M Lecture (102)	Discuss Exam #1 / Earth	*same as previous class*
	Online Lecture	Impacts	Chapter 9.3, Chapter 8.5
	W, F discussion (249 & 3113)	*Earth discussion*	*same as previous lecture*
10/4	M Lecture (102)	Meteorites / Asteroids	Chapter 14 (14.1, 14.2) Chapter 13 (13.1, 13.2)
	Online Lecture	Asteroids / Comets	Chapter 13 (all)
	W, F discussion (249 & 3113)	*Meteorites, Asteroids, and Comets discussion*	*same as previous two lectures*
10/11	M Lecture (102)	The Moon	Chapter 9 (9.1 – 9.4)
	Online Lecture	Mercury	Chapter 9 (9.5)
	W, F discussion (249 & 3113)	*Moon & Mercury discussion*	*same as previous two lectures*
10/18	M Lecture (102)	Venus	Chapter 10 (10.1–10.3, 10.6)
	W Exam (102)	**EXAM #2**	
	F Lecture (102)	Mars	Chapter 10 (10.1, 10.4–10.6)
10/25	M Lecture (102)	Discuss Exam #2 / Mars	same as previous lecture
	Online Lecture	Overview of Outer Solar System & Giant Planets	Chapter 11 (all)
	W, F discussion	*Mars discussion*	*same as previous two lectures*

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	(249 & 3113)		
11/1	M Lecture (102)	*NASA's OSIRIS-REx & Lucy missions*	*https://www.asteroidmission.org/* *http://lucy.swri.edu/*
	Online Lecture	Satellites of Jupiter	Chapter 12 (12.1, 12.2, 12.5)
	W, F discussion (249 & 3113)	*Missions & Outer Solar System & Giant Planets discussion*	
11/8	M Lecture (102)	Satellites of Jupiter & Satellites of Saturn	Chapter 12 (12.1, 12.2, 12.3, 12.5)
	Online Lecture	Satellites of Saturn	Chapter 12 (12.1, 12.3, 12.5) https://nineplanets.org/saturn/ (Moons)
	W, F discussion (249 & 3113)	*Satellites of Jupiter & Saturn discussion*	*same as previous two lectures*
11/15	M Lecture (102)	Satellites of Uranus	Chapter 12 (12.1) https://nineplanets.org/uranus/ (Rings and Moons)
	W Lecture (102)	Satellites of Neptune	Chapter 12 (12.1, 12.3) https://nineplanets.org/neptune/ (Rings and Moons)
	F Exam (102)	**EXAM #3**	
11/22	M Lecture (102)	Discuss Exam #3 / Kuiper Belt (including Pluto)	Chapter 12.4 https://solarsystem.nasa.gov/solar-system/kuiper-belt/in-depth/
	W Lecture (102)	*Class selected lecture topic*	*TBD*
	F	***No class*** – ***Thanksgiving***	
11/29	M Lecture (102)	Extra-solar planets	Chapter 21 (21.3–21.6)
	Online Lecture	Life in the Universe	Chapter 30 (all)
	W, F discussion (249 & 3113)	*Extra-solar planets and Life discussion*	*same as previous two lectures*

*** Readings may be modified during the semester. Changes will be announced in class and by e-mail.**
****These readings are recommended to support broad comprehension, but not required for lecture.**

Final Exam – Wednesday, Dec 8, 10:00 am – 12:00 pm (noon)

NORTHERN ARIZONA UNIVERSITY

SYLLABUS REQUIREMENTS

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://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.

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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 1, 2021