

Fundamentals of Planetary Science II

Course Syllabus – AST 502

Department/Academic Unit: Astronomy and Planetary Science

Term/Year: Spring, 2020

Total Units of Course Credit: 3

Mode of Instruction: face-to-face

General Information:

- Class Times: M/W/F 11:30 – 12:20 pm
- Location: Physical Sciences (Bldg #19) Room 218
- Instructors: Profs. Devon Burr and Josh Emery
 - Email: Devon.Burr@nau.edu and Joshua.Emery@nau.edu
 - Offices: Physical Sciences 315 and 323/324
 - Office Hours: Monday 2-3pm and by appointment

Course Purpose:

Geophysical and geologic processes occur throughout our Solar System. Thus, an understanding of these processes is a necessary foundation to understanding its past and present evolution, current state, and habitability potential. This course, following on AST501 Fundamentals of Planetary Science I, serves the PhD program in Astronomy and Planetary Science with the aim of continued development of students into stronger research professionals. Our ambition for each student in the course is the development of: i) a foundational understanding of planetary geophysical and geologic processes, and ii) enhanced skill in reading, understanding and presenting scientific literature, including a knowledge of the scientific methodology of hypothesis testing. These desiderata will be shaped both by independent work and in collaboration with other students.

Prerequisites: This course is an advanced, graduate-level course for students pursuing a PhD in astronomy and planetary science, the Earth sciences, or a related field. A working knowledge of undergraduate physics and advanced mathematics is expected, along with a familiarity with geologic and geophysical concepts. We're happy to suggest background reading materials if needed.

Course Student Learning Outcomes:

This course subserves the departmental Student Learning Outcome "Understand the physical processes in the present-day Solar System through high-level problem solving . . ." For students whose research focuses on the study of planetary surfaces, it subserves the further learning outcome "Understand the processes of planetary surface evolution and demonstrate this knowledge . . ." (<https://catalog.nau.edu/Catalog/details?plan=ASTPHD&catalogYear=1920>).

Assignments/Assessments of Course Student Learning Outcomes: The assignments that will be used to provide indications of student achievement of course Student Learning Outcomes are: 1)

homework, 2) presentation of one student-selected article, 3) analyses of student-selected articles, 4) mandatory meeting with us, and 4) a final exam.

1) Homework

- There will be six homework assignments. Their intent is to develop your comfort and skill with the material presented in class. Their ~bi-weekly cadence is designed to provide sufficient time for their thoughtful completion, including assimilation of material both presented in class and collected by you out of class.
- Collaboration is a hallmark of modern science. Please feel free to work together. At the same time, the submitted work must be the result of your own efforts. Indicate on the submitted work the individuals with whom you collaborated, whether receiving and/or providing help, and briefly for each individual the nature of that collaboration. Some journals (e.g., *Science*, *Nature*) require such statements on submitted manuscripts, so this course requirement will help prepare you for submitting manuscripts to such journals.
- Homework assignments will be built around calculations. State any assumptions and show neatly, with explanation when necessary, all steps in your work. This practice will both support your correct, logical reasoning and provide experience in explaining your work to others, as is necessary in teaching, scientific collaborations, manuscripts, meeting presentations, etc.
- Homework assignments might also include writing, a fundamental skill of a scientist in communicating their work. Any required writing will provide opportunities to practice this skill. When a written response is required, use complete sentences, correct grammar, correct spelling, and other components of standard scientific English.
- The distribution of points will be indicated on each assignment.

2) Presentation of one student-selected article

- You will each select and present to the class one article from the peer-reviewed scientific literature. The purpose of this assignment is to develop your skill in reading the scientific literature and in giving oral presentations. We will devote some time in the first few weeks of class to discussing effective approaches for giving oral presentations.
- These articles must be related to the course topics covered during the two preceding weeks of class and be approved by the course instructors no later than one week before they are scheduled to be presented. Journals such as *Science*, *Nature*, *Nature Astronomy*, *Nature Geosciences*, *Geophysical Research Letters*, *Geology*, and *PNAS* are fertile sources for appropriate and topical articles. Shorter topical articles from other journals are also appropriate.
- Presentations will be evaluated on the basis of a pre-defined rubric (available on the course Bblearn site). Information on oral presentation techniques is also available on the course site. We anticipate reviewing limited sections of this information in class.
- Students not presenting will provide constructive feedback to the presenter using this same evaluation form available on the Bblearn site. In addition to providing feedback to the presenter, a second purpose for this assignment is to promote thoughtful engagement among the listeners. After each presentation, everyone will have ~5 minutes to complete the forms. We will collect these forms and provide them to the presenter along with our own evaluation. The grade will be based on our evaluation only, and any

forms that contain any feedback that is non-constructive will not be passed to the presenter. These evaluations of fellow students are expected but not graded.

3) Write-ups of student-selected articles

- All students except the one who selected and is presenting the article will provide a written analysis of each student-selected article. The purpose of this assignment is to further develop the fundamental skill of reading the scientific literature and thereby to support your writing of scientific literature.
- Student-selected articles will be made available at least one week before they are scheduled to be presented, and a written analysis of each article is due on the day it is scheduled to be presented.
- This written analysis should be approximately one page in length and, in addition to the bibliographic information for the article, include five parts:
 - i) Background and motivation – why was this article written? What is the knowledge gap that the hypothesis addresses? How was the hypothesis motivated by previous work?
 - ii) Hypothesis to be tested – was it explicit or implicit in the article?
 - iii) Methods – Provide a brief statement of the methods used
 - iv) The outcome of the hypothesis testing – do the results support the ingoing hypothesis or not? Describe the logical reasoning used to assess the results in the context of the hypothesis.
 - v) Something new that you learned from the article and why this new knowledge is significant in the context of either the topic of the article or course material
 - vi) Something you didn't understand or weren't convinced by in the article and one or more ideas for future work in this areaExamples are provided on the course Bblearn site.
- Each of these six components will worth 15% with the remaining 10% based on quality of the writing.

4) **Mandatory Meeting with Instructors:** Students are required to have at least one in-person meeting with the instructors. The purpose of this meeting is to promote and support communication among the student and instructors; e.g., for the instructors to provide qualitative feedback on student achievements in the class, to hear from the student any means by which we could better support student achievement, and provide an opportunity to discuss any class-related issues that the student cares to share. The students bear the responsibility for scheduling this meeting, and we ask that it occur in February. They will be graded on the student showing up and being prepared for the meeting.

5) **Final Exam:** A final exam will take place Wednesday, May 6, from 10 am to noon in our classroom. The exam will be based on the homework assignments, which might well have been completed in collaboration with classmates and for which the students will have received graded feedback. Thus, this exam provides the opportunity for each student to independently demonstrate assimilation and understanding of the course materials. The distribution of points will be indicated on each question.

Textbooks: This course does not require any textbook purchases. Useful references include:

1) Melosh, [Planetary Surface Processes](#)

- 2) Turcotte and Schubert, Geodynamics
- 3) Lissauer & de Pater, Planetary Science
- 4) Stacy and Davis, The Physics of the Earth
- 5) Anderson and Anderson, Geomorphology: the mechanics and chemistry of landscapes

Grading: Overall course grades will be determined using the following weights:

- Homework 60%
- Paper Presentation 10%
- Article Write-ups 15%
- Mandatory Meeting 5%
- Final Exam 10%

Final letter grades will be assigned according to:

A = 90 – 100. B = 80 – 89. C = 70 – 79. D = 60 – 69. F = 0 – 59.

Course Topics Outline:

WEEK	~ DATES	LIKELY TOPICS
1	Jan 13,15, 17	Overview of the SS. Shape of Solar System bodies – Gravitational potential & strength.
2	Jan 22,24	Current SS dynamics. Sources of comets and NEOs.
3	Jan 27,29,31	Asteroids and Meteorites
4	Feb 3,5,7	Impact Cratering:
5	Feb 10,12,14	Regolith on airless bodies: observations and processes
6	Feb 17,19,21	Interior structures, heating, differentiation and convection. Deformation, topographic support
7	Feb 24,26,28	Tectonism: Types of faults Fault morphologies on terrestrial and icy bodies and implications
8	Mar 2,4,6	Volcanism: Observations and theory for silicate volcanism and cryovolcanism.
9	Mar 9,11,13 Mar 16,18,20	Make-up week – topics TBD (with student input) SPRING BREAK / LPSC
10	Mar 23,25,27	Slopes and mass movement, sublimation induced landforms. Mass wasting under microgravity
11	Mar 30, Apr 1,3	Aeolian processes and landscapes: mechanics and morphologies
12	Apr 6,8,10	Fluvial processes and landscapes: mechanics and morphologies
13	Apr 13,15,17	Ice: mechanics and morphologies
14	Apr 20,22,24	Rings, Kuiper Belt Objects
15	Apr 27,29, May 1	Make-up week – topics TBD (with student input)

Methods to detect processes on exoplanets: AST510.

Key Due Dates:

DATE	ITEM
JAN 24	Article sign-ups due on-line
FEB 5	HW#1
FEB 12	Singer+19 write-up due before class
FEB 14	Speyerer+16 write-up due before class
FEB 19	HW#2
MAR 4	HW#3
MAR 25	HW#4
APR 8	HW#5
APR 22	HW#6

Article Write-ups will be due *before the start of class* on the day each article is presented.

Course Policies:

- As noted above, collaboration is a fundamental aspect of science and is encouraged on homework assignments, with appropriate credit. Conversely, plagiarism –“ to steal and pass off (the ideas or words of another) as one's own : use (another's production) without crediting the source” (<https://www.merriam-webster.com/dictionary/plagiarize>) – is a fundamental breach of the principles of research. Evidence for plagiarism will be presented to and discussed with the student(s) involve. If substantiated, plagiarism will result in a failing grade for the assignment and, potentially, referral to the University. See policy.nau.edu/policy/policy.aspx?num=100601 for NAU’s policies on academic integrity.
- Homework and Article Write-ups are due before the start of class on their respective due dates. Homework are due in hard copy with pages stapled together. We prefer that the Article Write-ups be submitted electronically – either posted on Bblearn or (if you run into problems posting) by email addressed to both of us.
- Each student may turn in one assignment of each type – one Homework and one Article Write-up – up to one week late without penalty for this lateness. No reason or prior notification is needed. Any subsequent late assignment(s) would not receive any credit, although we will grade such assignments to provide feedback on the work.
- If you must be unexpectedly absent on the day that you are scheduled to present your article, please let us know as soon as you are able. As our class will be depending on you to lead the discussion that day, we ask you to make all reasonable efforts to fulfill this responsibility.
- Final Exam – If you cannot attend the final exam, please let us know as soon as possible. If you miss the exam without this prior notification, you will be able to make it up only under exceptional circumstances.

Standards of Conduct and Attendance: We ask everyone to practice civility, including a genuine respect and valuing of others. Please attend every class possible, let us know when you will miss class, and be fully present in class to support group learning as well as to maximize your own benefit from the course. If you feel that the behavior of any class member – professor or student

– is discriminatory, harassing, or otherwise impedes learning, please refer to the resources on the following pages for help in addressing this behavior.

Feedback: Feedback on this course is welcome. Please let us know what you like about the course and / or whatever we could do to enhance your learning. We'd be glad to receive information through the following means: (1) speaking to one or both of us, (2) sending one or both of us an email. Any feedback you provide, no matter how praiseworthy or critical, will not affect your grade in any way.

If a situation arises about which you do not feel comfortable communicating directly with either of us, please discuss your concerns with another member of the Graduate Program Committee (David Trilling or Ty Robinson), and they will support and assist you in finding appropriate means to resolve the issue and/or communicate with us about it.

SYLLABUS POLICY STATEMENTS

ACADEMIC INTEGRITY

NAU expects every student to firmly adhere to a strong ethical code of academic integrity in all their scholarly pursuits. The primary attributes of academic integrity are honesty, trustworthiness, fairness, and responsibility. As a student, you are expected to submit original work while giving proper credit to other people's ideas or contributions. Acting with academic integrity means completing your assignments independently while truthfully acknowledging all sources of information, or collaboration with others when appropriate. When you submit your work, you are implicitly declaring that the work is your own. Academic integrity is expected not only during formal coursework, but in all your relationships or interactions that are connected to the educational enterprise. All forms of academic deceit such as plagiarism, cheating, collusion, falsification or fabrication of results or records, permitting your work to be submitted by another, or inappropriately recycling your own work from one class to another, constitute academic misconduct that may result in serious disciplinary consequences. All students and faculty members are responsible for reporting suspected instances of academic misconduct. All students are encouraged to complete NAU's online academic integrity workshop available in the E-Learning Center and should review the full academic integrity policy available at <https://policy.nau.edu/policy/policy.aspx?num=100601>.

COURSE TIME COMMITMENT

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

DISRUPTIVE BEHAVIOR

Membership in NAU's academic community entails a special obligation to maintain class environments that are conducive to learning, whether instruction is taking place in the classroom, a laboratory or clinical setting, during course-related fieldwork, or online. Students have the obligation to engage in the educational process in a manner that does not interfere with normal class activities or violate the rights of others. Instructors have the authority and responsibility to address disruptive behavior that interferes with student learning, which can include the involuntary withdrawal of a student from a course with a grade of "W". For additional information, see NAU's disruptive behavior policy at <https://nau.edu/university-policy-library/disruptive-behavior>.

NONDISCRIMINATION AND ANTI-HARASSMENT

NAU prohibits discrimination and harassment based on sex, gender, gender identity, race, color, age, national origin, religion, sexual orientation, disability, or veteran status. Due to potentially unethical consequences, certain consensual amorous or sexual relationships between faculty and students are also prohibited. The Equity and Access Office (EAO) responds to complaints regarding discrimination and harassment that fall under NAU's Safe Working and Learning Environment (SWALE) policy. EAO also assists with religious accommodations. For additional information about SWALE or to file a complaint, contact EAO located in Old Main (building 10), Room 113, PO Box 4083, Flagstaff, AZ 86011, or by phone at 928-523-3312 (TTY: 928-523-1006), fax at 928-523-9977, email at equityandaccess@nau.edu, or via the EAO website at <https://nau.edu/equity-and-access>.

TITLE IX

Title IX is the primary federal law that prohibits discrimination on the basis of sex or gender in educational programs or activities. Sex discrimination for this purpose includes sexual harassment, sexual assault or

relationship violence, and stalking (including cyber-stalking). Title IX requires that universities appoint a “Title IX Coordinator” to monitor the institution’s compliance with this important civil rights law. NAU’s Title IX Coordinator is Pamela Heinonen, Director of the Equity and Access Office located in Old Main (building 10), Room 113, PO Box 4083, Flagstaff, AZ 86011. The Title IX Coordinator is available to meet with any student to discuss any Title IX issue or concern. You may contact the Title IX Coordinator by phone at 928-523-3312 (TTY: 928-523-1006), by fax at 928-523-9977, or by email at pamela.heinonen@nau.edu. In furtherance of its Title IX obligations, NAU will promptly investigate and equitably resolve all reports of sex or gender-based discrimination, harassment, or sexual misconduct and will eliminate any hostile environment as defined by law. Additional important information about Title IX and related student resources, including how to request immediate help or confidential support following an act of sexual violence, is available at <http://nau.edu/equity-and-access/title-ix>.

ACCESSIBILITY

Professional disability specialists are available at Disability Resources to facilitate a range of academic support services and accommodations for students with disabilities. If you have a documented disability, you can request assistance by contacting Disability Resources at 928-523-8773 (voice), 928-523-6906 (TTY), 928-523-8747 (fax), or dr@nau.edu (e-mail). Once eligibility has been determined, students register with Disability Resources every semester to activate their approved accommodations. Although a student may request an accommodation at any time, it is best to initiate the application process at least four weeks before a student wishes to receive an accommodation. Students may begin the accommodation process by submitting a self-identification form online at <https://nau.edu/disability-resources/student-eligibility-process> or by contacting Disability Resources. The Director of Disability Resources, Jamie Axelrod, serves as NAU’s Americans with Disabilities Act Coordinator and Section 504 Compliance Officer. He can be reached at jamie.axelrod@nau.edu.

RESPONSIBLE CONDUCT OF RESEARCH

Students who engage in research at NAU must receive appropriate Responsible Conduct of Research (RCR) training. This instruction is designed to help ensure proper awareness and application of well-established professional norms and ethical principles related to the performance of all scientific research activities. More information regarding RCR training is available at <https://nau.edu/research/compliance/research-integrity>.

MISCONDUCT IN RESEARCH

As noted, NAU expects every student to firmly adhere to a strong code of academic integrity in all their scholarly pursuits. This includes avoiding fabrication, falsification, or plagiarism when conducting research or reporting research results. Engaging in research misconduct may result in serious disciplinary consequences. Students must also report any suspected or actual instances of research misconduct of which they become aware. Allegations of research misconduct should be reported to your instructor or the University’s Research Integrity Officer, Dr. David Faguy, who can be reached at david.faguy@nau.edu or 928-523-6117. More information about Misconduct in Research is available at <https://nau.edu/university-policy-library/misconduct-in-research>.

SENSITIVE COURSE MATERIALS

University education aims to expand student understanding and awareness. Thus, it necessarily involves engagement with a wide range of information, ideas, and creative representations. In their college studies, students can expect to encounter and to critically appraise materials that may differ from and perhaps challenge familiar understandings, ideas, and beliefs. Students are encouraged to discuss these matters with faculty.