Course 460-224 : *Geology of Moons and Planets*

Instructor: Jeremy S Delaney
Office: Wright Geological Laboratory jsd@rci.rutgers.edu
Offered in Spring Semester by Department of Earth & Planetary Sciences

***LEARNING GOALS*:** Students will learn the key concepts and principles leading to an understanding of our current models for the formation and evolution of the bodies in our Solar System. Moons and thousands of other small objects such as asteroids and comets, as well as the planets themselves provide the potential targets of study principles for understanding the origin and nature of our physical world. The course includes the interaction of our home planet (Earth), with its larger environment (the Solar System) and the changing role of society from passive observer to active explorer preparing for future exploitation of the extraterrestrial resources.

This course satisfies SAS Core Curriculum Goals:
Areas of inquiry – ***Natural Sciences*** – *STUDENTS WILL BE ABLE TO:*
"**GOAL e"**. Basic principles and concepts in planetary science are used to:

a. Recognize and explain the occurrence of the various planetary objects of the Solar System and modern interpretations of remote sensing and sample studies (meteorites) of the bodies of the Solar System.
b. Class #1: Introduction. The class centers on the use of "remote sensing" which literally means acquiring data without touching it. To gather Information about the objects in the Solar System. Data produced from recording of the ultraviolet, infrared and microwave regions of the EM (electromagnetic) spectrum. The velocity and wavelength of the EM energy can changes as it passes through different media like air, rock, water, ice, or interstellar space). In addition, equipment on aircraft and space craft, such as, cameras, scanners, and lasers provide data.
c. Classes #3 and #5: These classes focus on meteorites, the only extraterrestrial rock samples that scientists currently have available
d. Class #2. Basic forces such as gravity and magnetic fields are determined by observations of the nature of the orbit (gravity) and by remote sensing form satellite missions (gravity).

i. A general theme throughout the course is to examine, the methods, evidence, hypotheses, and theory of planetary evolution that result from 45 years of intense scientific exploration since the era of the Apollo Moon Landings in 1969.
ii. Classes #14-16 and class #21-27 cover each of the planets that have been visited by missions.

"GOAL f" (i) The student will assess both the limitations and capabilities of scientific method as applied to our planetary setting. Examples are classes #!2 and #13. The Earth's moon has been linked to crime, suicide, mental illness (lunatics), disasters, accidents, birthrates, fertility and werewolves.

These ideas are perpetuated by the media and too often are not refuted. This class follows step-by-step through early observations of the moon as facts were gathered. Early interpretations established three competing hypotheses of the origin of the moon. The misconceptions of the moon are discussed.

a. Descartes (17th C) thought the moon was captured into orbit by Earth.
b. George Darwin (1830) [father of Charles Darwin] suggested the moon split from the Earth (fission hypothesis)
c. Gilbert (1930) suggested the moon accreted from billions of small particles in orbit around the sun.

These hypotheses were tested and rejected, only when evidence was brought back by the Apollo missions 1969-1973. The current model for formation of the moon favors a giant impact formrd the binary Earth-Moon system early in the period of planet formation in the Solar System.

(ii) Classes #14- #18 involve the understanding of the physical context for the interactions between Earth and its neighbors, the other rocky planets. How do adjacent planets affect each other?

This course, also satisfies ***21st Century Challenges***

"**GOAL c"** Student will be able to analyze the relationship that science and technology have to a contemporary social issue.

This course will address a broad social issue called *"**scientific literacy**"* which includes written, numerical, and digital literacy as they pertain to the understanding of science, its methodology, observations, and theories. A literate citizen should be able to evaluate the quality of scientific on the basis of its source and the methods used to generate it. However, a significant portion of US population (>50%) does not accept biological evolution, for example. 20-40% (depending on the poll) do not accept that humans are the cause of the current global climate change. UFO (unidentified flying objects and ET (extraterrestrial) beings are often reported on the news. A number of unmanned missions are underway, and as we prepare for future exploration of the solar system for extraterrestrial resources and/or life it is critical that all citizens are science literate. A course such as this provides access to the scientific literature and ***requires no prerequisites***

Students will assess the necessity of the intensely interdisciplinary regimen (geology, physics, chemistry, astronomy and biology) applied to international and commercial space programs. Classes # 6, #7 and #8 In particular, discuss the origin and characteristics of comments, asteroids, and meteorites and assess human exposure to, and the appropriate response to the well documented extraterrestrial hazards (Earth-crossing Asteroids or Near-Earth-Objects).

No prerequisites. This survey course is designed to be accessible by a wide range of students and no specific background is required.

ASSESSMENT

Class sizes for this course have historically been between 80 and 140 students since it was first taught over 20 years ago. The core curriculum requirements will be assessed based upon three exams that will evaluate the students mastering of Learning Goals c,e,f, by employing the core curriculum generic rubrics. Because of the relatively large classes, the exams are generally multiple choice examinations.

Examples of questions that might be asked on these exams include:

Q1: How can we mitigate the significant threat to modern society posed by Solar System objects approaching the earth (NEO's)?
Q2: Evaluate the importance of water in the transition from the inner to the outer Solar System.
Q3: The association of numerous moons with giant planets contrasts with their scarcity around the rocky planets. Why?
Q4. What commercial return may be gained from the exploration and development of asteroidal bodies beyond the Earth-Moon system?
Q5. The statement, "Gravity always wins", is a compact expression for what set of ideas, central to Solar System evolution?
Q6. Why is the concept of an "enabling technology" so critical for exploration in the Solar System, and how is relevant in the 21st Century?

Assessing achievement

Three exams including a final exam: ~33% per exam

Score		***Goals c,e,f***
A:	90-100;	outstanding
B+:	84-90;	
B:	78-84;	Good
C+:	72-78;	Satisfactory
C:	66-72;	
D:	50-66;	Unsatisfactory
F:	<50	

Attendance: All students must attend all classes, arrive on time, remain in class until the end of the class period, and participate in class discussions.

'Pop' quizzes based on assigned web readings will be used throughout the semester to permit reiteration of course concepts

Syllabus including the proposed Core Goal(s)

The Geology of Moons and Planets will explore the formation of planets and other bodies in the Solar System.
The course has three major segments;

I. The formation of materials from which the eight planets and approximately one hundred and eighty moons were formed and their relationship to the star at the center of the Solar System.
II. The planets;
   a. The construction of the four rocky planets of the inner Solar System and the similarities and differences between them. This includes discussion of the habitable zone where abundant life has thrived for the past 3.5 billion years (and longer).
   b. The formation of the four giant planets and the multitude of moons associated with them in outer Solar System and the role of water in their assembly.
   c. The minor bodies of the Solar System and the contrast between the inner and outer Solar System and the importance of water.
III. Planetary systems beyond our Solar System.

Textbook: Because of the rapid evolution of planetary sciences during the past 50 years, the textbooks that survey the discipline become obsolete in about two years and are of insufficient scope for the current geologically-oriented course. For this reason the course will use a variety of web resources that focus on specific aspects of the subject. These URL are more readily updated as the science progresses.

Basic Web Sources

Jet Propulsion Lab: Caltech	*www.jpl.nasa.gov/index.html*
	photojournal.jpl.nasa.gov/index.html
Mars Rovers	*http://marsrovers.jpl.nasa.gov/gallery/all/opportunity.html*
NASA headquarters resources	*http://solarsystem.nasa.gov/multimedia*
	nssdc.gsfc.nasa.gov/imgcat
Lunar & Planetary Institute	*www.lpi.usra.edu/*
European Space Agency	*http://www.esa.int.html*
PlanetarySpace Summary Reviews	*www.psrd.hawaii.edu/index.html*

Schedule of Classes for
460:224 GEOLOGY OF MOONS AND PLANETS: SPRING 2015

Class	**Topic**		**Date**	
1	Introduction: overview of Solar System		Jan	
2	Elements, Stars and the Solar System		Jan	
3	Meteorites and the Protoplanetary Disk		Jan	
4	Meteorites, Collisions and Accretion		Feb	
5	Impact and Cratering		Feb	
6	Planetary forming Processes		Feb	
7	Comets		Feb	
8	Asteroids: Orbits, Compositions, Hazards		Feb	
9	Review 1		Feb	
10	**EXAM 1**	Classes. 1-8	Feb	
11	Earth: an unusual binary planet		Feb	
12	Moon: Surface observations		Mar	
13	Moon: deeper exploration and origin		Mar	
14	Mercury Close to the sun		Mar	
15	Venus : Hot and nasty		Mar	
16	Mars : the next stop for humanity		Mar	
17	No classes Spring Break		Mar	
18	Rocky Planets 8: Missions to Mars: from Viking to Maven; SNC meteorites & Life		Mar	
19	Review 2		Mar	
20	**EXAM 2**	Classes. 9-18	April	
21	Giant Planets 1; Jupiter		April	
22	Giant Planets; Satellites		April	
23	Giant Planets; Saturn and rings		April	
24	Giant Planets; Saturn Satellites		April	
25	Giant Planets; Uranus; rings / satellites		April	
26	Giant Planets; Neptune ; Triton, Pluto : Kuiper Belt		April	
27	Challenges to humanity in Space		April	
	Review 3			
	CLASSES END		May	
	FINAL EXAM 8-11am,	Classes. 10-27	May	

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Grades Final grade will be the weighted average of grades for the exams and quizzes, which will be based on material designed to achieve the stated learning goals of the course.
Office Hours In principle, unless otherwise occupied, you can see me anytime I am here. Please E-mail prior to coming to ensure that I am available and is best for simple questions.