Journey Through the Solar System Syllabus

Department of Earth and Environmental Sciences

ERTH2020 Fall 2024

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Course Instructor(s)

Name	Email	Office Hours
Richard Cox	richard.cox@dal.ca	TBD

Course Description

The course offers an introduction to the geological features of the planets, asteroid belt, and major satellites of our solar system, and the current understanding as to their formation. The course will use the Earth as an analog to compare the landforms, and both the measured and inferred geology of the solar system.

Course Prerequisites

All students must be in their 2nd year. No specific course prerequisites are required. Note: that a general understanding of physical sciences and basic mathematics will be necessary to successfully complete the course.

Course Exclusions

N/A

Student Resources

Lectures will be available on Brightspace after they have been presented in class. Materials for practical exercises will be brought to class for use. The TEAMS course space will be available for questions and discussions and all other materials will be listed Brightspace.

Course Structure

Course Delivery

2 Lectures and one tutorial per week

Lectures

Tuesday and Thursday 10:05-11:25 AM

Tutorials

Friday 9:35-11:35 AM

Course Materials

Required Textbook:

Claudio Vita-Finzi and Dominic Fortes **"Planetary Geology"** ISBN 978-1-78046-015-4

Other materials required:

Other materials will be posted on Brightspace.

Assessment

Parts 1 and 2:

Class Quizzes (11 in total x 2% each). Best 10 are counted, so **20%** of your final mark. These must be completed on-line.

Part 1:

Practical Exercises (4 in total x 5% each). So, **20%** of your final mark. These are to be completed using your computer and data you will collect or which will be provided. We will use some of the tutorials to go through these and then you will have to plot and summarize your results and then submit then on Brightspace.

Part 2:

Terrane Analysis Exercises (4 in total x 5% each). So, once again **20%** of your final mark. These are also to be completed using your computer and the maps and other data provided for each planetary body (the Moon, Mercury, Venus and Mars), written-up and submitted through Brightspace.

Term Project:

"Design your mission" (see description in lec 0-2 and in the instructions on Brightspace in the Mission Project Folder). This involves mission design in Part 1 and data analysis and interpretation in Part 2 of the course.

- Part 1 (mission statement) = 10%
- Part 2 (mission report) = 10%

Completed project = **<u>20%</u>** of your final mark.

Final Exam

Cumulative exam covering the entire course. To be scheduled by the registrar and = 20% of your final mark.

Other course requirements

Regular attendance at lectures, reading the required course materials thoroughly and most importantly, a genuine enthusiasm for studying in a wide range of science and technology disciplines.

Conversion of numerical grades to Final Letter Grades follows the <u>Dalhousie Common Grade Scale</u>

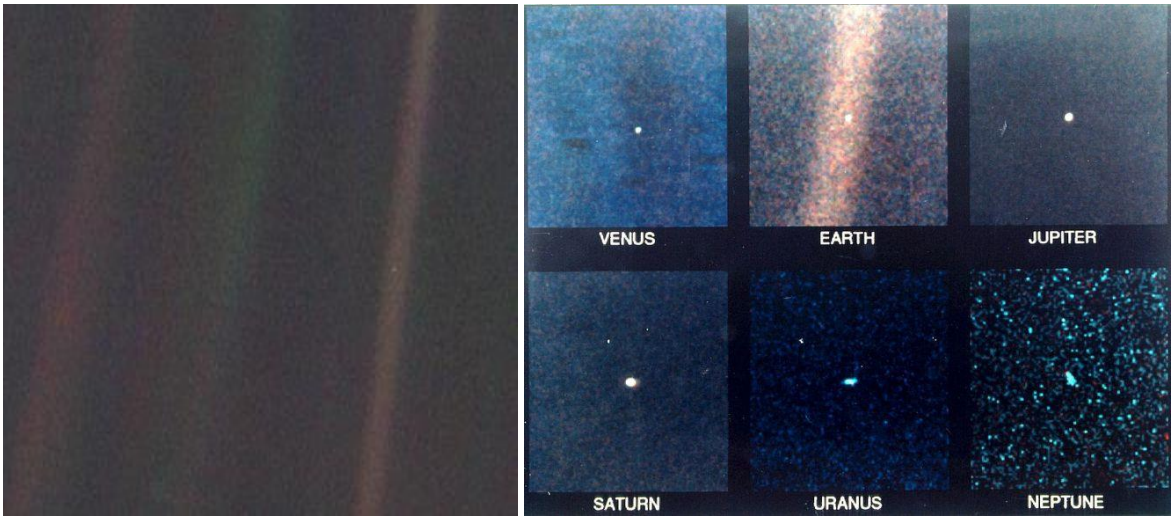
A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (<50)
A- (80-84)	B- (70-72)	C- (55-59)	

Course Objectives/Learning Outcomes

Why is this course called ERTH2020? The Voyager missions are probably the most successful examples of exploration of our solar system that have ever been carried out. On August the 25th, 2012, Voyager I became the first object launched by us to leave our solar system after completing a 35 year long journey. One of the last images taken by Voyager was called at the time "The Pale Blue Dot". The tiny blue dot visible in the centre right of the image (below) is the Earth from 6.44 billion km away. This was one a series of images of our solar system captured in 1990. Voyager II is also currently on its way out of our solar system and will also leave the Solar System by 2020, having been the only spacecraft to have visited all of the outer planets. As we watch these two fragile man-made objects become interstellar spacecraft, we will look back at our own solar system, and review what we have discovered using some of the information gathered by these historic missions.

Why study the planets? To understand how the Earth works we look at the current and recent geological record of events and apply our understanding of these events to model the processes that have shaped the Earth over the course of the last 4.5 billion years. In other words, the present is the key to the past, a concept known as uniformitarianism. However, because the Earth is a shaped by different

dynamic processes, and contains widely contrasting environments, we simply do not have a complete geological record. By examining other planetary bodies in our solar system we can hopefully see a record of events that are not preserved on Earth. However, there is more to this field of study. It is often the differences rather than the similarities between the Earth and her neighbors that are the most striking. By recognizing these differences, and understanding why they occur in our solar system, we gain a greater insight into the workings of our home planet. The Earth is our home, and for the foreseeable future, is the only home we will ever have. Is it not wise to understand how your home was built and how it works?



“The Pale Blue Dot” (left). Part of series of image of our solar system taken by Voyager I (right). The images from http://voyager.jpl.nasa.gov/imagesvideo/imagesbyvoyager.html.

The overall goals for this course: To examine the ongoing exploration of terrestrial planets, larger moons, asteroids, comets and Kuiper Belt objects in our solar system; to recognize the main features present on these planetary bodies and compare them with those on Earth; to understand the main geological processes involved in the formation of these planetary bodies.

Learning outcomes: The learning outcomes include, but are not restricted to;

1) To gain a basic knowledge of how the planets and satellites in our solar system are studied and the analytical methods that have been used, and are currently being used.

2) To gain knowledge about the age, composition and structure of the main geological features of the terrestrial planets, asteroids, comets, the main satellites of the outer planets, and dwarf planets of our solar system.

3) To understand how the main geomorphological features of extraterrestrial planetary bodies in the solar system have formed and how these compare to the Earth.

4) To apply the knowledge gained during the course to create your own mission package which will help you to solve a particular problem in Solar System exploration.

5) To evaluate and analyze a data set delivered by your mission package which will help solve a specific geological problem.

6) To appreciate the importance of pushing the boundaries of understanding and why we must continue to explore our solar system.

Course Outline

Part 1: Understanding the methods and results of planetary exploration

During this part of the course the lectures will address the following:

a) The order and structure of the planets, their moons and the Asteroid and Kuiper Belts.
b) The age of the planets and a general model for the formation of the Solar System.
c) Why do we explore?
d) What can we tell about a planetary body's geological history?
e) What can we measure and how do we do it?
f) Manned versus unmanned missions.

During this first part of the course, we will also have practical exercises to help illustrate the methods, used and results obtains, when exploring our solar system. These will be scheduled during regular lecture times or tutorial times. You must attend scheduled practical sessions.

Practical exercises include (subject to change):

a) The scale of the solar system.
b) Understanding geophysics (gravity, seismics and magnetics).
c) Understanding spectroscopy
b) Basic petrology and geology
e) Impact densities and ages of planetary surfaces

Quizzes 1, 2, 3 and 4 on the age and composition of the solar system will be due before the end of part one of the course.

This will also set-up the first part of the term project where you will be required to design your mission and have it approved by the mission director. Time will be set aside both in class, and during extra office hours on the week of Oct 15th-18th, to meet with the director and discuss your mission proposal. Launch date is Oct 31st!

Part 2: Exploring our solar system: The Terrestrial planets and the Asteroid Belt

During this part of the course the lectures will present a view of each of the terrestrial planets and the major moons of the solar system and examine and/or address following:

The Earth, our home and native land.

a) The surface of the Earth.
b) The structure of the Earth.
c) Plate tectonics.
d) The composition of the Earth.
e) Geological processes and geological cycles.
h) A brief global geological history: When did this all occur?

Luna, our nearest neighbor

a) A history of lunar exploration.
b) The far side and near side: The main features of the Moon and her composition.
d) A Geological history of the Moon.

The inner planets; Visits to Venus and Mercury

a) The main geological features of the Venus.
b) Venus Earth's (evil) twin? A comparison between Venus and the Hadean Earth.
c) The current understanding of the geology of Mercury.

Mars: The Red Planet

a) The main geological features of Mars.
b) Geological environments on Mars: rocks, weathering, winds and sand.
c) Where on Earth is Mars? A comparison of geological terranes.

The Asteroid Belt

a) The large-scale structure of the Asteroid Belt.
b) The study and classification of meteorites: a planet in the making.
c) Mini-planets: Vesta, Ceres and other bits and pieces.

Quizzes 5, 6, 7 and 8, which specifically address the study of these planets and moons, will also be due at the end of part 2 of the course.

Part 3: The Outer Solar System

During the last part of the course we will look at the outer part of the solar system, and will cover the following:

The Servants of the Gods: The moons of the outer planets

a) The Galilean Moons: Ganymede, Callisto, Io and Europa.
b) The rings and moons of Saturn and the mystery of Titan.
c) The moons of Uranus and Neptune and the capture of Triton.

The Outer Limits: Comets and the Kuiper Belt

a) What are comets and where do they come from?
b) Pluto and the dwarf planets.
c) The Kuiper Belt and Oort Cloud. What do we know?

The Journey Continues: Future missions

a) Current and future missions: Where do go from here and why?
b) Can we really live in space, the Moon, Mars?
c) Summary and Conclusions

Quizzes 9, 10 and 11 will cover this section of the course and will be due by the end of the semester.

Your mission data, which will form the second part of your term project, will also be presented at this stage. Coupled with the lectures from parts 1 and 2, you should be able to interpret the data and finish your mission. Time will again be set aside to discuss this part of your term project.

Term Project: Design your own Mission

The term project involves two parts each worth a maximum of 15% of your course mark when properly completed. For part 1, you will be assigned a specific exploration problem (e.g. examining volcanism on Venus, the relative chronology of events recorded by Mercury, the search for water on the Moon, comparing the chemical composition of the asteroids, a study of plate tectonics on Europa, etc.). Once you have read the basic mission statements and goals you will have to complete and submit a mission proposal which will include a basic mission and instruments package and what data you wish to gather. This is done by completing the mission statement form on-line through Brightspace. You may of course consult with the mission directors (course instructors and demonstrators) beforehand. Your mission will either be approved with a mark awarded based on how successfully you have designed your mission package, or rejected because the requested mission package will not fulfill the mission goals. You may

resubmit your proposal but 5% of your mark will be deducted for each failed attempt. After three attempts your mission package will be assigned for you and half of your project mark will have been lost (15% of the course total). Launch date (deadline for part 1) is Nov 1st.

The second part of the project involves the launch and deployment of your mission package and data return. You will have to evaluate, interpret and report on the data gathered and produce a short final report which is also completed using the template provided on Brightspace. You should be presented with your data by Nov 8th so that you can dedicate part of the study week (Nov 11th – 15th) to look through the information. Again, you can consult with the mission directors while you are preparing your final report. You will be marked on your interpretation of your data and how well your mission has met the scientific goals set. A further 15% of your final course mark will be awarded at this stage and your final project mark calculated. Deadline for your final mission report (part 2) is Tuesday Dec 3rd, the final day of classes.

University Policies and Statements

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: https://www.dal.ca/about-dal/internationalization.html

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html)

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: http://www.dal.ca/cultureofrespect.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at:

https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at: https://www.dal.ca/about/leadership-governance/academic-integrity/faculty-resources/ouriginal-plagiarism-detection.html

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.