Journey Through the Solar System Syllabus

Department of Earth and Environmental Sciences

ERTH2020 Fall 2023

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	Online live sessions to be arranged during the semester

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

Not open to students in their 1st year.

Student Resources

The class will be divided into study groups to facilitate dialog and live learning sessions through the course TEAMS space during the semester. The live learning sessions will be used to help with course materials, quizzes, practical exercises and the term project. Attendance at these sessions is not required.

Course Delivery

Lectures will be asynchronous, online and narrated. These can be downloaded as Powerpoint files or streamed on Brightspace through Panopto. Note: If you watch the Powerpoint files on Brightspace you will not be able to hear the recorded lecture. The folders with each set of lectures will be released once per week.

Laboratories

None. However, materials for practical exercises and quizzes will be posted in the relevant weekly course folder and will be released when applicable.

Tutorials

None, although live learning sessions on TEAMS will be arranged as required.

Course Materials

Required Textbook:

Claudio Vita-Finzi and Dominic Fortes **"Planetary Geology"** ISBN 978-1-78046-015-4. Available from the Dal Bookstore and as an e-text from several booksellers.

Other materials will be posted on Brightspace. Some household items may be used for some of the practical exercises but are not essential. A cell phone or tablet will allow the recommended free aps to be downloaded and used for some practical exercises. A calculator, ruler and basic stationary supplies will also be required. You will also be required to use MS Office which is available to all Dal students.

Assessment

Class Quizzes (12 in total x 2%). These must be completed on-line through Brightspace. You will have a three-hour time interval to complete each quiz once it has been started. The lowest two marks will be dropped and therefore the quizzes are worth up to **20%** of your final mark

Practical Exercises for Part 1: (4 in total x 5% each = up to **20%** of your final mark). These must be submitted on-line through Brightspace.

Terrane Analysis Exercises for Part 2: (4 in total x 5% each = up to **20%** of your final mark). These must be submitted on-line through Brightspace.

Term Project "Design your mission" (see description below). Mission design, data collection and objective completion (2 parts x 10%) = **20%** of your final mark.

Final Exam: Will be completed online with some materials will be posted in advance. You will have 3 hours to complete the final exam when started = **20%** of your final mark. **Note: The final exam date and time will be scheduled by the registrar.**

Other course requirements

Studying the lectures, exercises and quizzes and reading the required course materials thoroughly is obviously required. The most important requirement is having a genuine enthusiasm for studying in a wide range of science and technology disciplines to help understand our corner of the universe.

Conversion of numerical grades to final letter grades follows the Dalhousie Grade Scale

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (0-49)
A- (80-84)	B- (70-72)	C- (55-59)	

Course Policies on Missed or Late Academic Requirements

Keeping up to date with all the posted materials is essential. This course will be delivered in an asynchronous manner, i.e. it will be posted in two parts and you will have a limited time to work through each sub-section to complete each part.

Using the TEAMS discussion boards for help and attending live learning sessions is strongly encouraged. Quizzes and assignments submitted on Brightspace after the deadlines will not be graded.

Term project modules (2 parts) submitted late without reasonable and documented cause will be deducted 50% after the deadline and a further 10% per day. Term project modules completed more than 5 days late will not be graded. Failure to complete part 1 of the project will prevent you from completing part 2 of the term project and you will lose 20% of your marks for the course.

The final exam will be held online at a date and time scheduled by the registrar. Failure to complete the exam at this time will result in a loss of 20% of your final mark.

Course Policies related to Academic Integrity

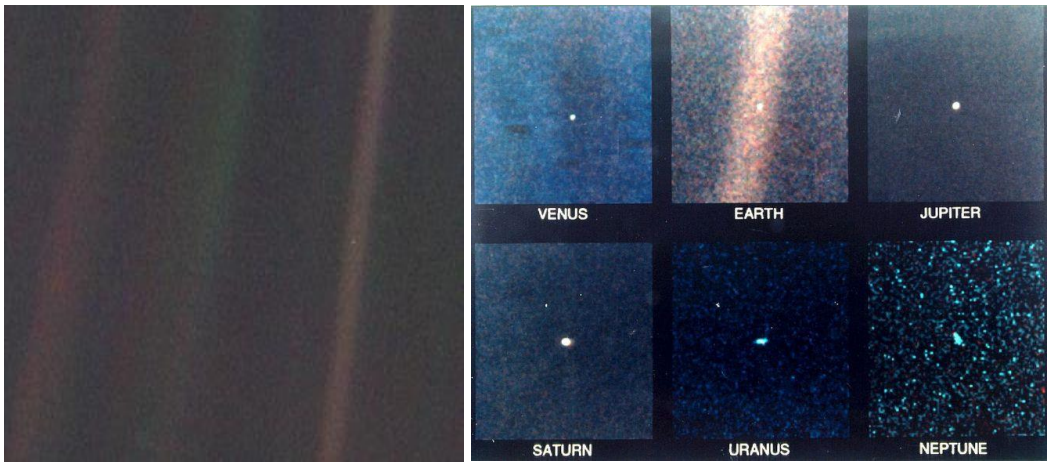
We will follow Dalhousie University's policies on academic integrity as described below. As the quizzes and final exam are essentially open book tests, you can refer to notes, etc. as you complete them. However, they are time limited, so you should be prepared before starting them on Brightspace. Use of AI bots will not help you complete the practical exercises or your term project and should not be used when completing the course.

Learning Objectives

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 Content

Part 1: Understanding the methods and results used during a planetary exploration mission

During this part of the course the lectures will be split into two sub-sections (1a and 1b) which will be posted separately in order to allow you time to focus on each set of individual topics. Part 1 of the course 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) What can we measure and how do we do it?

d) What can we tell about a planetary body's geological history?

e) The missions and why do we explore?

During this first part of the course lectures will also be tied to short quizzes and practical exercises to help illustrate the methods used, and results obtained, when exploring our solar system. Practical exercises include:

Part 1a: Measuring the physical properties of planetary bodies in the solar system.

Ex 1. The scale and distribution of planets in the solar system.

Ex 2. Understanding basic geophysics: (i) gravity, (ii) topography, (iii) magnetic fields and (iv) seismic data.

Part 1b: The geology, geochemistry and ages of the formation of the solar system

Ex 3. Impact craters, impact densities and the ages of planetary surfaces.

Also, during part 1 of the course, we will be using the Earth as our analog while investigating the methods employed when exploring the rest of our solar system. The following topics will be covered in parallel with the description of the methods and techniques used in solar system exploration including:

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?

We will also have a practical exercise to illustrate the dynamic nature of the Earth;

Ex 4. Oceanic Plates on Earth: A simple terrane analysis exercise.

The quizzes and assignments related to each of these topics will be due before the dates posted in the course calendar on Brightspace.

Term project part 1: You will have to plan your mission package and write your missions statement during part 1 of the course. The information required to start will be available during orientation week and you can begin your research at any stage. Time will be set aside to discuss your term project during the live learning sessions and a TEAMS discussion board will also be available to post questions.

Part 2: Exploring our solar system

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> This part of the course will be presented as whole during the last three weeks of the course. You will be able to examine the planets and moons in any order, but it is advised that you work through the lectures in the order listed below. Pat two of the course is where you will apply the knowledge gained in part of the course to examine and/or address following:

The Moon, 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.

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 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.

The Asteroid Belt and Jupiter.
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.
d) The Jovian System and the Galilean Moons: Ganymede, Callisto, Io and Europa.

Saturn and the outer limits.
a) The rings and moons of Saturn and the mystery of Titan.
b) The moons of Uranus and Neptune and the capture of Triton.
c) Pluto and the dwarf planets.
d) Comets, the Kuiper Belt and Oort Cloud. What do we know?

The quizzes and terrane analysis exercises related to these topics will be due before the dates posted in the course calendar on Brightspace.

Term project part 2: Your mission data, which will be based on your mission statement and mission package, and which forms the second part of your term project, will be presented at the start of part 2. Coupled with the lectures 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 and the discussion board will also remain available for questions.

Term Project: Design your own Mission

The term project involves two parts each worth a maximum of 20% 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 (10% of the course total). Launch date (deadline for part 1) will be at the end of week 10 of the course on **November 17th**, which is also the study break.

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 will be presented with your data during week 11 of the course. 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 10% of your final course mark will be awarded and your final project mark calculated. The deadline for your final mission report (part 2) is **Dec 6th**, the final day of classes for this course.

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/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.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.