

**Faculty of Science Course Syllabus**  
**Department of Earth Sciences**  
***ERTH2020 A Journey Through the Solar System***  
***Fall Semester 2019***

**Instructor(s):** *Richard Cox (richard.cox@dal.ca)*

**Lectures:** *2 per week (Monday and Thursday 8:35-9:55PM)*

*Location: LSC common area (Room C334)*

**Laboratories:** *N/A*

**Tutorials:** *N/A*

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### **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**

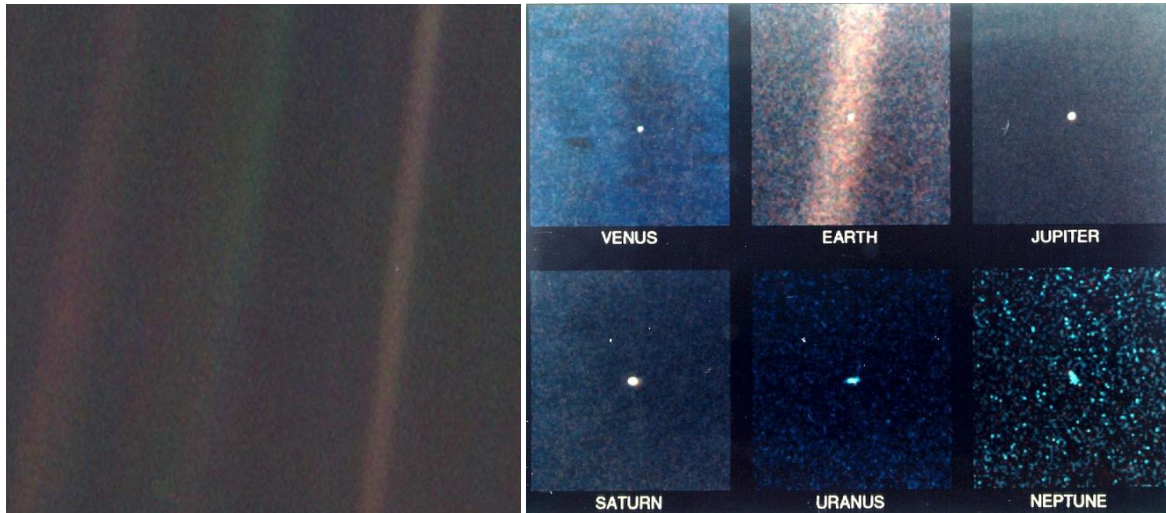
All students must be in their 2<sup>nd</sup> year. No specific course prerequisites are required. Note: that a general understanding of physical sciences and basic mathematics will be necessary to successfully complete the course.

### **Course Objectives/Learning Outcomes**

**Why is this course called EARTH2020?** The Voyager missions are probably the most successful examples of exploration of our solar system that have ever been carried out. On August the 25<sup>th</sup>, 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 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.

## 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 obtained, when exploring our solar system. These will be scheduled during regular lecture times but the class will be split during the weeks when we have a practical exercise. You must attend your scheduled practical session.

Practical exercises include (subject to change):

- a) The scale of the solar system.
- b) Basic petrology and geology
- c) Understanding geophysics (gravity, seismics and magnetics).
- d) Understanding spectroscopy
- 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 weekly during 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 15<sup>th</sup>-18<sup>th</sup>, to meet with the director and discuss your mission proposal. Launch date is Nov 1<sup>st</sup>!

### **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 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.

*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.

*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 5, 6, 7 and 8, which specifically address the study of these planets and moons, will also be due weekly during this section of the course.***

Your mission data, which will form the second part of your term project, will be presented at this stage. Couple 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.

### **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 1<sup>st</sup>.

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 8<sup>th</sup> so that you can dedicate part of the study week (Nov 11<sup>th</sup> – 15<sup>th</sup>) 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 3<sup>rd</sup>, the final day of classes.

### **Course Assessment**

*Class Quizzes (8 in total x 5% each as described above). The best 4 marks will be counted = **40%** of your final mark). These must be must completed on-line.*

*Term Project "Design your mission" (see description above). Mission design, data collection and objective completion (2 parts x 15%) = **30%** of your final mark.*

*Final Exam, which will be cumulative (scheduled by the registrar) = **30%** 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 Dalhousie Common Grade Scale**

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 Policies**

Attendance at all lectures is required. In-class exercises may be presented and will greatly help towards understanding the graded materials during the semester. Quizzes submitted on Brightspace after the deadline 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. Note: You will be required to complete each module of the term project in order. Failure to complete a module will prevent you from completing the rest of the term project. See the description of the Term Project above for further details.

### **University Policies and Statements**

**This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate**

#### **Academic Integrity**

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of 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.

**Information:** [https://www.dal.ca/dept/university\\_secretariat/academic-integrity.html](https://www.dal.ca/dept/university_secretariat/academic-integrity.html)

#### **Accessibility**

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia).

**Information:** [https://www.dal.ca/campus\\_life/academic-support/accessibility.html](https://www.dal.ca/campus_life/academic-support/accessibility.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.

**Code:** [https://www.dal.ca/dept/university\\_secretariat/policies/student-life/code-of-student-conduct.html](https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html)

#### **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

**Statement:** <http://www.dal.ca/cultureofrespect.html>

#### **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 (1321 Edward St) ([elders@dal.ca](mailto:elders@dal.ca)).

**Information:** [https://www.dal.ca/campus\\_life/communities/indigenous.html](https://www.dal.ca/campus_life/communities/indigenous.html)

**Important Dates** in the Academic Year (including add/drop dates)

[https://www.dal.ca/academics/important\\_dates.html](https://www.dal.ca/academics/important_dates.html)

**University Grading Practices**

[https://www.dal.ca/dept/university\\_secretariat/policies/academic/grading-practices-policy.html](https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html)

**Missed or Late Academic Requirements due to Student Absence (policy)**

[https://www.dal.ca/dept/university\\_secretariat/policies/academic/missed-or-late-academic-requirements-due-to-student-absence.html](https://www.dal.ca/dept/university_secretariat/policies/academic/missed-or-late-academic-requirements-due-to-student-absence.html)

**Student Resources and Support**

**Advising**

**General Advising** [https://www.dal.ca/campus\\_life/academic-support/advising.html](https://www.dal.ca/campus_life/academic-support/advising.html)

**Science Program Advisors:** <https://www.dal.ca/faculty/science/current-students/academic-advising.html>

**Indigenous Student Centre:** [https://www.dal.ca/campus\\_life/communities/indigenous.html](https://www.dal.ca/campus_life/communities/indigenous.html)

**Black Students Advising Centre:** [https://www.dal.ca/campus\\_life/communities/black-student-advising.html](https://www.dal.ca/campus_life/communities/black-student-advising.html)

**International Centre:** [https://www.dal.ca/campus\\_life/international-centre/current-students.html](https://www.dal.ca/campus_life/international-centre/current-students.html)

**Academic supports**

**Library:** <https://libraries.dal.ca/>

**Writing Centre:** [https://www.dal.ca/campus\\_life/academic-support/writing-and-study-skills.html](https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html)

**Studying for Success:** [https://www.dal.ca/campus\\_life/academic-support/study-skills-and-tutoring.html](https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html)

**Copyright Office:** <https://libraries.dal.ca/services/copyright-office.html>

**Fair Dealing Guidelines** <https://libraries.dal.ca/services/copyright-office/fair-dealing.html>

**Other supports and services**

**Student Health & Wellness Centre:** [https://www.dal.ca/campus\\_life/health-and-wellness/services-support/student-health-and-wellness.html](https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html)

**Student Advocacy:** <https://dsu.ca/dsas>

**Ombudsperson:** [https://www.dal.ca/campus\\_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html](https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html)

**Safety**

**Biosafety:** <https://www.dal.ca/dept/safety/programs-services/biosafety.html>

**Chemical Safety:** <https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>

**Radiation Safety:** <https://www.dal.ca/dept/safety/programs-services/radiation-safety.html>

**Scent-Free Program:** <https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>

**COPYRIGHT**

All members of the Dalhousie community are expected to comply with their obligations under Canadian copyright law. Dalhousie copyright policies and guidelines, including our Fair Dealing Guidelines, are available

at <http://www.dal.ca/dept/copyrightoffice.html>. Copyright questions should be directed to the Copyright Office at [copyright.office@dal.ca](mailto:copyright.office@dal.ca).

### SERVICES AVAILABLE TO STUDENTS

The following campus services are available to help students develop skills in library research, scientific writing, and effective study habits. The services are available to all Dalhousie students and, unless noted otherwise, are free.

Service	Support Provided	Location	Contact
<b>General Academic Advising</b>	Help with <ul style="list-style-type: none"> <li>- understanding degree requirements and academic regulations</li> <li>- choosing your major</li> <li>- achieving your educational or career goals</li> <li>- dealing with academic or other difficulties</li> </ul>	<b>Killam Library Ground floor</b> Rm G28 <b>Bissett Centre for Academic Success</b>	In person: Killam Library Rm G28 By appointment: <ul style="list-style-type: none"> <li>- e-mail: <a href="mailto:advising@dal.ca">advising@dal.ca</a></li> <li>- Phone: (902) 494-3077</li> <li>- Book online through MyDal</li> </ul>
<b>Dalhousie Libraries</b>	Help to find books and articles for assignments Help with citing sources in the text of your paper and preparation of bibliography	<b>Killam Library Ground floor</b>  Librarian offices	In person: Service Point (Ground floor)  By appointment: Identify your subject librarian (URL below) and contact by email or phone to arrange a time: <a href="http://dal.beta.libguides.com/sb.php?subject_id=34328">http://dal.beta.libguides.com/sb.php?subject_id=34328</a>
<b>Studying for Success (SFS)</b>	Help to develop essential study skills through small group workshops or one-on-one coaching sessions  Match to a tutor for help in course-specific content (for a reasonable fee)	<b>Killam Library 3<sup>rd</sup> floor</b>  Coordinator Rm 3104  Study Coaches Rm 3103	To make an appointment: <ul style="list-style-type: none"> <li>- Visit main office (Killam Library main floor, Rm G28)</li> <li>- Call (902) 494-3077</li> <li>- email Coordinator at: <a href="mailto:sfs@dal.ca">sfs@dal.ca</a> or</li> <li>- Simply drop in to see us during posted office hours</li> </ul> <b>All information can be found on our website: <a href="http://www.dal.ca/sfs">www.dal.ca/sfs</a></b>
<b>Writing Centre</b>	Meet with coach/tutor to discuss writing assignments (e.g., lab report, research paper, thesis, poster) <ul style="list-style-type: none"> <li>- Learn to integrate source material into your own work appropriately</li> <li>- Learn about disciplinary writing from a peer or staff member in your field</li> </ul>	<b>Killam Library Ground floor</b> Learning Commons & Rm G25	To make an appointment: <ul style="list-style-type: none"> <li>- Visit the Centre (Rm G25) and book an appointment</li> <li>- Call (902) 494-1963</li> <li>- email <a href="mailto:writingcentre@dal.ca">writingcentre@dal.ca</a></li> <li>- Book online through MyDal</li> </ul> We are open six days a week  <b>See our website: <a href="http://writingcentre.dal.ca">writingcentre.dal.ca</a></b>