

Course: TERRESTRIAL ENERGY SYSTEMS

Course Number: CIV 300H1F, ENV 346H1F

Instructor: Ian Sinclair, P.Eng., MEng&Man
ianc.sinclair@utoronto.ca
<http://individual.utoronto.ca/IanSinclair/>
www.towardsnetzero.org

Time: *Scheduled Teaching Periods:* Monday 9 – 11 AM. Wednesday 9 - 10 AM. First lecture Monday September 13th . Note: these dates won't be followed as **the course is being delivered asynchronously**, due to limits in place as a result of the large class size. This is a Faculty decision. However, the first introductory lecture will be **live** in order to at least set the stage for the course and introduce myself in person. After this first lecture, all remaining lectures will be pre-recorded and posted.

In order to compliment the above-noted lectures, one lecture time slot per week will be delivered live in order to review specific topics/questions/concerns - a kind of group office hour or review session of the highlights of previously delivered material. Students will be asked to submit requests for material to be covered ahead of time, while I will occasionally cover a single topic, perhaps driven by the news cycle. Due to the size of this class (250+ students), this cannot act as a one-on-one process.

The 'live' slot will take place at 10 AM on Monday morning using a Zoom link to be posted on Quercus (new this year – BB Collaborate is no longer offered by the University). This is not mandatory and will take place during the 9AM Monday time slot.

Textbook: A custom and dedicated TES textbook **is required** to be purchased and is available in the U of T Bookstore as a hard copy to cover the key course requirements. There is also an electronic version available at a cost of \$53.95. The following text comes from Cengage, the publisher.

Custom eBook: An Energetic Earth, CIV300/ENV346, ISBN:9780176911584.

For **direct purchase links** and **instructions** on how to access your digital resources, visit this link:https://www.cengage.com/coursepages/UoT_F21_CIV300. Get 10% off when you purchase from Cengage.ca by October 31st, 2021. Coupon code: "DIGITALB2S1090". You can also purchase this from the UT bookstore's eCampus Bookstore but you cannot use the coupon there .

How Do I Get Help? Individual help can be sought via email (I can and do respond quickly), via purpose-set up Discussion Boards within Quercus, and via Teaching Assistants (specifically for tutorial and course help).

Tutorials: Tuesday from 6 to 8 pm (though we will often finish earlier). These will be live in order to ensure TA's are available to students, given the significant timetabling constraints at play with this large course. They will be a mixture of 'lecture style' which

each TA will generate their own format, and supervised breakout room group work within Zoom, whereby a TA will oversee small student groups (5 or less) who work collaboratively in private groups. The TA's will 'circulate' to help out. Please consider this methodology – I believe it is more beneficial than a passive lecture approach to reviewing questions.

Course Overview

This course overviews various systems of energy storage and transformation within our own environment, namely the Earth, and as relates to our sources of energy – notably the sun. The energy systems considered include solar, atmospheric, subsurface and oceanic systems. Convection, conduction and radiation are explored as key transfer mechanisms between these systems. Energy transformations, the Earth's energy balance, energy transport mechanisms in the atmosphere and the oceans due to circulation, currents, evaporation and precipitation - together with the key couplings and interactions that connect these into a planetary system – are reviewed. These together make up what we know of as weather, seasons and major dramatic events like hurricanes and earthquakes.

Motivation

Energy issues are becoming increasingly prominent, notably the specific aspects of carbon intensity, price, source, storage, price stability, long-term sustainability, energy security, climate change amongst numerous other issues. While acutely aware of and partly motivated by these human issues - founded on the notion that energy is indispensable to humanity, this course is not about applications; rather it considers actual scientific processes resulting in these energy transformations that we see on planet Earth.

The desire is to provide detailed background on terrestrial systems as they function at both large and small scales, and to seek an overview of the "natural" functioning of the whole planet from an energy perspective. The goal is to understand both the Earth and energy well enough that key concepts can be explained, related and recognized in scientific and popular writing, and that these concepts can be used quantitatively in simple assessments. As the Anthropocene continues to modify Earth's natural energy cycles, understanding the basic concepts is vital if we are to reduce the impacts of human-induced climate change.

A desired outcome of the course is for engineers and environmental specialists to understand that the world around them is part of an energy system and not a static body without external influence. By understanding our own environment, we stand a better chance of understanding those which we seek to alter and how we have altered our own.

Informal Prerequisites. A general background/interest in science and a desire to understand your surroundings; reasonably proficient writing, reading and communication skills; basic skills in math and algebra; a desire to learn about the world you live in technically and quantitatively. This is NOT a calculation-heavy course, rather the study and application of key concepts that have remarkable outcomes that we know first-hand by living on an active planet. That's not to say that we cannot quantify and as such numerical analysis is a part of the course.

Course Roll Out

The course will be broken down into the following five Modules. While they are self-contained, material will recur and evolve throughout the course. Basic concepts will be studied and then applied as we seek to understand some of the 'big stuff': weather, major events including hurricanes, earthquakes and tsunamis.

Module 1 – Energy in our Own Backyard

- Module 2 – Air and Water Fundamentals, Consequences for Earth Energy Systems
- Module 3 – Applications in Weather
- Module 4 – Ocean Currents & Waves
- Module 5 – Earth’s Structure

Course-Level Learning Outcomes

Upon successful completion of this course, you will be able to:

- Understand the role of energy on Earth: its sources and how it changes form
- Apply basic laws in order to quantify and evaluate the amount of energy Earth receives from the sun and how it is distributed on Earth.
- Analyse fundamental properties of air and water including the application of psychrometrics (the quantification of air’s energy content in relation to water vapour, and dry air masses) in order to understand how energy transfer and fluid movement occurs on our planet
- Apply air/water concepts to understand weather patterns at a local and global scale including extreme examples including hurricanes, tornados and thunderstorms
- Apply basic concepts to understand waves and ocean currents, including the study of tsunamis
- Understand Earth’s sub-surface structure and its impacts on the surface

By the end of each Module you will be able to:

Module	Learning Outcome
Module 1 – Energy in our Own Backyard	<ul style="list-style-type: none"> • Apply basic laws in order to quantify the energy Earth receives from the sun and how it is distributed. • Study the role of the moon and sun and apply that learning to understanding Earth’s seasons.
Module 2 – Air and Water Fundamentals, Consequences for Earth Energy Systems	<ul style="list-style-type: none"> • Analyse the fundamental properties of air and water in relation to the redistribution of energy on Earth. • Evaluate how energy exchange impacts water’s phase changes and their key role in energy transportation. • Understand how that redistribution is experienced as weather, climate and human comfort.
Module 3 – Applications in Weather	<ul style="list-style-type: none"> • Analyse how basic laws characterise air movement and scale and the resulting weather outcomes • Understand and analyse major storm types: thunderstorms, tornados, hurricanes
Module 4 – Ocean Currents & Waves	<ul style="list-style-type: none"> • Understand and evaluate concepts of water and energy transportation within the oceans • Apply these concepts to large ocean waves and tsunamis
Module 5 – Earth’s Structure	<ul style="list-style-type: none"> • Understand basic concepts to evaluate Earth’s sub-surface structure and its outcomes • Apply those concepts to plate tectonics and earthquakes

Tutorials

There will be 6 practice problem sets (PPS) to give hands-on exposure to primarily numerical applications of the various topics and **these will make up the key material** on which the tests and exam will be based. Tutorials are based on the Modules. Having said that, any and all material covered in lectures and tutorials is ‘fair game’ for the test and exams. The final exam will cover ALL the material from the course.

Tutorials are posted on the Wednesday for the following week's Tuesday tutorial. They are not mandatory and submissions are not required.

Complete solutions to the PPS will be posted prior to the quizzes and exams.

Evaluation

Your mark for the course will be calculated as follows. Please note the different outcomes for those in the CIV300 stream and those in the ENV346 stream.

Assessed Material	CIV300	ENV346
Three quizzes after module 1 though 3	60%	
Two quizzes after module 1 and 2		45%
Short written assignment	5%	
Essay and presentation (ENV346 only)		20%
Final Exam (In Person, Type C; aid sheet permitted, with non-programmable calculators)	35%	35%

The short written assignment (CIV300 only) will be set towards the end of the semester. It is a reflective learning exercise and will not be onerous. The ENV346 essay will be more detailed and will include your own choice of terrestrial energy topic to study, reflect upon and present to your peers. Details to follow.

The quizzes will take place once the lectures and associated tutorials for each respective module have taken place. They will therefore lag the completion of the lecture work for each Module by a week or two. They will be a mixture of multi-choice questions as a random selection from a bank of questions (completed on-line as a Quercus quiz) and by submitting an electronic response to a longer question.

Quiz Dates: quizzes will take place during tutorial time and will be 'live', unless you require a time zone or other accommodation. There will be a time allocation for the quiz, with additional time for uploading.

Quiz 1: Tuesday October 5th.

Quiz 2: Tuesday October 26th

Quiz 3: Tuesday November 16th

As these dates may change, do not make commitments during any tutorial times. Note that there are no make up quizzes. If **you** have programmed a conflict into your schedule, **you** are responsible for meeting your quiz times and dates for this course. This course is multi-department/multi-faculty, so accommodations are not possible due to timetabling.

Plagiarism Review

Normally, students will be required to submit their course essays to the University's plagiarism detection tool for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the tool's reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of this tool are described on the Centre for Teaching Support & Innovation web site (<https://uoft.me/pdt-faq> (Links to an external site.)).

References and Texts

The textbook covers material in detail that is covered in lectures and also provides review questions. Additional references and resources will be made available during the course. Note that the book was revised for fall 2016

(3rd edition). It was also revised for fall 2013 (2nd edition). There are some chapter variations in all three editions; as a result if you choose an older version, not all referenced material will be present.

Accessibility Needs

Students with diverse learning styles and needs are welcome in this course. The University of Toronto is committed to accessibility: if you require accommodations for a disability, or have any other accessibility concerns about the course, please contact [Accessibility Services](#) as soon as possible.

Interactive Discussion Board

I will set up a discussion board on Quercus which will be a place to post questions and answers. This is as much for you to help each other as for me or a TA to moderate, although that will take place. Students in particular have made good use of this prior to quizzes and exams in order to solve questions. This is encouraged. Just be clear that any assessed work is **NOT** to be discussed using this forum as that constitutes a breach in academic integrity.

APPROXIMATE COURSE OUTLINE

Weeks 1-3 Introduction and Key Concepts: *Overview of the course, energy and environment, introduction to terrestrial energy, overview of Earth's energy balance, energy as global currency, Earth in space and time.*

Weeks 4-5 Physics of the Earth: *Overview of transformations of heat, work; quantitative statements of the 1st law of thermodynamics and energy forms; phase change, thermal stratification, and chemical reactions; key terrestrial energy carriers and transfers; dry and moist air, psychometric relations.*

Weeks 6-10 The Atmosphere and the Oceans: *Basic models of the atmosphere and the Earth's energy balance: reflection, refraction and absorption; weather and climate systems, hydrologic coupling; atmospheric circulation, Coriolis force and geostrophic wind, effect of cloud cover and humidity, effect of land and sea, effect of elevation and aspect. Oceanography, oceanic circulation, shallow and deep circulations, hydrologic cycle, energy transport mechanisms in the oceans. Snow and ice formation, winter impact.*

Weeks 11-12 Water Bodies & Waves: *Waves, tides, currents, tsunamis.*

Week 13 Subsurface Systems: *Introduction to plate tectonics, earthquakes and volcanoes.*

On Academic Integrity:

Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters (<https://governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019>) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

In papers and assignments:

1. Using someone else's ideas or words without appropriate acknowledgement.
2. Submitting your own work in more than one course without the permission of the instructor.
3. Making up sources or facts.
4. Obtaining or providing unauthorized assistance on any assignment.

On tests and exams:

1. Using or possessing unauthorized aids.
2. Looking at someone else's answers during an exam or test.
3. Misrepresenting your identity.

In academic work:

1. Falsifying institutional documents or grades.
2. Falsifying or altering any documentation required by the University.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see <https://www.academicintegrity.utoronto.ca/>).

Plagiarism has been detected over the past two semesters as a result of students copying and collaborating for quizzes and exams. Sanctions were applied and students' graduation schedules and new careers were delayed as a result of this process. Don't do it. You know it's wrong.

Health and Wellness

Please see the following web site for FAQs regarding COVID. Note the stipulation at the end of the web page regarding the requirement (or lack of) for a doctor's note in case you miss a deadline or quiz. You are expected to self-record absences on ACORN.

<https://studentlife.utoronto.ca/covid-19-health-wellness-faqs/>

Copyright Notice

Students in the past have taken it upon themselves to post course teaching material onto 3rd party web sites, presumably for some form of compensation. This is not only ethically dubious, it's also an infraction of Copyright, given the student has only been provided the material by the course instructor for their own purposes.

Course materials prepared by the instructor are considered by the University to be an instructor's intellectual property covered by the Copyright Act, RSC 1985, c C-42. These materials are made available to you for your own study purposes, and cannot be shared outside of the class or "published" in any way. Lectures, whether in person or online, cannot be recorded without the instructor's permission. Posting course materials or any recordings you may make to other websites without the express permission of the instructor will constitute copyright infringement.