Course: **TERRESTRIAL ENERGY SYSTEMS**

Course Number: CIV300H1F, ENV346H1F

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Time: *Lectures:* Monday 9-11AM, WB116. Wednesday 9-10AM, MC102. First lecture Monday September 12th.

Tutorials: Tuesday from 6 to 8 pm (though we will often finish earlier). Room number and tutorial styles to be confirmed. To begin Tuesday 27th September. Note that you are NOT to go to your assigned ROSI room (you will for tests however). Online is expected to be an available option.

Textbook: A custom and dedicated TES e-textbook can be purchased and is available in the U of T Bookstore as an electronic (or hard copy) to cover the key course requirements. **An Energetic Earth, CIV300/ENV346 ISBN: 9781774742914**
The electronic version is available at a cost of $60.95.
https://www.cengage.ca/c/custom-ebook-energetic-earth44-civ300env34644-uoft-2e-ahrens/jackson/jackson/9781774742914/?searchIsbn=9781774742914 This is integrated into Quercus for the first time. Purchase of the text is highly recommended.

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). They will be a mixture of 'lecture style' which each TA will generate their own format, and supervised study groups/individual work. The TA will 'circulate' to help out. Please consider this methodology – I believe it is often 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	• 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	• 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. Focus on winter. • Understand how that redistribution is experienced as weather, climate and human comfort.
Module 3 – Applications in Weather	• 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	• 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	• 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's 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
Mini assignment (CIV300 only), essay/presentation (ENV346 only)	**4%**	**20%**
2 Tutorial quizzes (mark based on best 3 of 4 parts)	**46%**	**-**
2 Tutorial quizzes (best 2 out of 3 parts)	**-**	**30%**
Final Exam (Type C; aid sheet with calculators)	**50%**	**50%**

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 and longer written/numerical questions.

Quiz Dates: quizzes will take place during tutorial time in person.

Quiz 1: Tuesday October 18th
Quiz 2: Tuesday November 22nd

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 has undergone 4 editions with some chapter variations in all editions; as a result, if you choose an older hard-copy 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 transformations of heat, work; quantitative statements of the 1st law of thermodynamics and energy forms; phase change overview of Earth's energy balance, energy as global currency, Earth in space and time.*

Weeks 4-6 Physics of the Earth:, *air and water as energy carriers, thermal stratification, and chemical reactions; key terrestrial energy carriers and transfers; dry and moist air, psychometric relations.*

Weeks 7-10 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 three 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 regarding COVID. As we are all used to by now, guidance can and may evolve over time.

https://www.utoronto.ca/utogether/covid-19-planning-update

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