Proposal Information

Type:
New Course

Title:
New Course: PHY 110

Log Number
13439-2024

College:
College of Liberal Arts and Sciences

Department:
Physics Department

Author:
Richard Vallery

Syllabus of Record

Course Data

Course Code
PHY 110

Title
The Physics of Climate Change

Credits
3

Prerequisites
MTH 110

Description
Introduction to the physics of climate change and climate modeling. Introduces the physical processes that determine the Earth's temperature and its variation due to long-time-scale natural effects and contemporary anthropogenic influences. Topics include energy/equilibrium, blackbody radiation, the greenhouse effect, heat transfer by convection, and climate change timescales.

General Education

This course teaches and assesses the General Education Student Learning Outcomes that correspond to the Physical Sciences Foundation as outlined in the General Education handbook.

Syllabus of Record

Objectives
After successful completion of the course the students will be able to

1) **Comprehension/Describe:**
Describe the temperature and carbon dioxide time series over geological and contemporary timescales.

2) **Comprehension/Explain:**
Explain how blackbody radiation of the Sun and albedo of the Earth determine the average incident solar energy flux.

3) **Synthesis/Explain:**
Explain how physical parameters impact climate model predictions.

4) **Analysis/Analyze:**
Analyze the effect of carbon dioxide (and other gases) on incident radiation of varying frequencies.

5) **Analysis/Experiment:**
Experiment with objects and gases, demonstrating transparency/opaqueness to incident radiation of varying frequencies.

6) **Analysis/Calculate:**
Calculate the equilibrium temperature of the earth with and without an atmosphere, and then including the effects of convection.

7) **Evaluation/Estimate:**
Estimate the uncertainties in measurements, e.g., of temperature and of proxy data, and in climate model output.

8) **Comprehension/Describe:**
Describe the scientific conclusions presented in technical reports (e.g., by the Intergovernmental Panel on Climate Change (IPCC)) and media articles about climate change.

9) **Analysis/Illustrate:**
Illustrate how evaporation and condensation of water occurs, and its dependence on temperature and humidity.

10) **Adaptation/Build:**
Build simple models of atmospheric energy transfer, leading to situations of equilibrium and/or "forcings" from out-of-equilibrium situations.

Topics

Common Topics (physics-mathematical content; applications)

- Units; Timescale and history of Earth and Life (1 week)
- Measurement, Uncertainty, Temperature; Overview of contemporary climate change (1 week)
- Energy, Thermodynamics, Energy Transfer, Equilibrium (1-2 weeks)
- Electromagnetic Spectrum, Blackbody Radiation; Radiative equilibrium of a planet (1-2 week)
- Absorption-emission of light by matter; Earth's atmosphere and the "greenhouse effect" (2-3 weeks)
- Phase Transitions, Convection; Water, Temperature in the troposphere, Radiative-Convective equilibrium of a planet (2-3 weeks)
- Orbital and rotational motion of the Earth; Paleoclimate record, Milankovich cycles (1 week)
- Absorption lines; "climate sensitivity": the effect of increasing CO2 on temperature (1 week)
- Timescales of climate changes (1 week)

Discretionary Topics

- Computational Modeling of climate change (1 week)
- Oceans and Ice (1 week)

Methods of Evaluation

- Classroom preparation and participation (e.g., reading quizzes); Discussion assignments; Homework assignments 10 - 50%
- Exams, Group Exams, Standards-based Evaluations; Projects 10 - 50%
- Weekly Laboratory Assignments 30%

All categories could include individual or group assignments, as desired by the instructor. Care should be taken, however, to ensure that General Education standards can be assessed (at the level of the individual student).

Sample Source(s) of Information

Course Textbook:

Andrew E. Dessler, Introduction to Modern Climate Change (3rd Ed 2021)

Other potential resources for students and instructors:

Jeffrey Bennett, A Global Warming Primer: Pathway to a Post-Global Warming Future (2nd Ed, Big Kid Science, 2024)

Frank Levin, Global Warming: Truth and Consequences (1st Ed, Springer, 2023)

Steve Koonin, Unsettled (1st Ed, BenBella, 2021) [Note: This is a climate-change-skeptic-adjacent book, written by a physicist. He essentially does not question the consensus science of anthropogenic climate change, but focuses on uncertainties in climate models, and argues against the misuse of uncertain scientific conclusions in the media.]

Additional Resources:

The course materials will be supplemented by lecture notes written by physics faculty members, and a laboratory manual created by GVSU physics faculty.

Consult the **SOR guidelines** when developing or revising syllabi of record.