SEF 533 Global Climate Change

School: **Engineering and Science**

Course Title: **Global Climate Change**

Program(s): Science & Engineering Foundations for Education (SEFE) – Interdisciplinary

Course #: SEF 533

Catalog Description:

The phenomenon of global change and the impact on the Earth's large scale climate systems of human activity will be studied by using scientific inquiry and the application of concepts from the first three courses. Topics include the analysis of the flow of energy in the Earth system, the energy transformations that lead to the greenhouse effect and the scientific data that has been used to establish the current scientific viewpoint. We will also discuss socio-political issues that have become a key component in the discussion of global change.

Course Objectives

This course provides an important link in the Science & Engineering Foundations for Education Graduate Certificate Program by connecting the Principles of Earth Science to the national and global energy crisis via the issues related to global climate change. This knowledge and practice will enable teachers to utilize key topic materials and resource to be prepared to address the topic formally or informally in their own classrooms.

List of Course Outcomes:

The following Course Outcomes are based on the *Understanding By Design* framework that was utilized in the development of this course. After SEFE 533 participants will have the following:

Transfer

Students will be able to independently use their learning to better understand what light and heat energy are and what energy transformation are as they apply to the atmosphere and climate.

Enduring Understandings

1. Energy is a measure of the ability of one physical system to change another physical system; or the capacity to produce changes.

2. Energy transformations represent changes in potential and kinetic energy in a system as energy flows through it. This energy may change form as it flows (electrical, radiant, mechanical, heat) but the quantity of energy does not change.

Essential Questions

1. How does light energy transform into heat energy at a molecular level as a basis for affecting weather and climate?

2. Does the amount of electromagnetic radiation received by the Earth change over time? Why does it change?

Acquisition of Knowledge

Students will know

1. The study of energy is important to climate science

Acquisition of Skills

Students will be skilled at:

1. Explaining light and heat energy as it relates to the climate
2. Applying an understanding of energy to other systems

Transfer

Students will be able to independently use their learning to explain the mechanisms by which the Earth stays in radiative balance and what factors change this balance.

Understandings

1. Changes in the Earth's energy budget and internal energy transformations can cause changes in climate patterns.
2. The greenhouse effect is the process by which thermal energy is absorbed by greenhouse gases in the upper atmosphere and re-radiated. This process is important to Earth's climate.
3. CO_2 is an important greenhouse gas and is a component of the carbon cycle.

Essential Questions

1. What happens to the energy inside the Earth system?
2. What is climate & climate change?
3. To study climate change what data and methods would we use?
4. What are some examples of natural and anthropogenic causes of climate change?
5. How do greenhouse gases work at the molecular level to warm the climate?
6. What is the impact of the carbon cycle on climate?

Acquisition of Knowledge

Students will know:

1. Energy is transformed and transferred throughout Earth's system
2. Energy transformations relate to the climate and climate change

Acquisition of Skills

Students will be skilled at:

1. Demonstrating the heat absorbing/re-radiating properties of greenhouse gases

Transfer	
Students will be able to independently use their learning to explain what computer and mathematical models are & how they are used and develop simple examples.	
Understandings 1. Computer and mathematical models are used to analyze changes in Earth's energy budget, internal energy transformations and carbon cycle.	**Essential Questions** 1. How do math and computer models help us understand climate change? 2. What errors can arise in using models and what impact does that have on understanding and predicting climate and climate change?
Acquisition of Knowledge Students will know 1. Computer and math models in play a significant role in climate science 2. What different types of climate models do such as a Global Circulation Model or Energy Balance Model.	**Acquisition of Skills** Students will be skilled at: 1. Building a simple math model 2. Analyzing systematic and random error to determine the source of error

Transfer	
Students will be able to independently use their learning to interpret the scientific data that support the scientific explanations for our assessment of the climate	
Understandings 1. Paleoclimatology is critical to predicting future climates. 2. Determining past temperature and atmospheric composition requires a combination of forensic science and archeology.	**Essential Questions** 1. How has the climate changed in the past? How do we know that?
Acquisition of Knowledge Students will know 1. Tree ring data, ice and mud core data and other proxy measurements give scientists insight into past climates.	**Acquisition of Skills** Students will be skilled at: 1. Making inferences that can be linked together into a casual model.

Transfer Students will be able to independently use their learning to interpret the role humans plays in affecting the climate	
Understandings 1. Humans plays a role in changes that occur to the Earth's atmosphere by impacting the carbon cycle by adding more carbon or preventing carbon from cycling naturally 2. Technology can mitigate the role humanity plays in negatively affecting future climates.	Essential Questions 1. What are anthropogenic impacts on the carbon cycle? (What is a carbon footprint? What is carbon sequestration?) 2. What are some ways, technological or behavioral, to mitigate our impact?
Acquisition of Knowledge Students will know: 1. Mechanisms by which humans have affected the climate 2. The socio-political ideas that mitigate our impact on climate and climate change	Acquisition of Skills Students will be skilled at: 1. Analyzing implications of subsystems manipulations on system dynamics

Prerequisites: Students must be part of CIESE's NSF funded PISA^2 program cohort for the initial offering of this course. Alternative prerequisites will be developed at the end of the PISA^2 program so that the courses may be offered for general use.

Cross-listing: N/A

Grading Percentages: Online discussions and assignments (50%)

Final (20%)

Final Project (30%)

Credits: **3 credits**

For Graduate Credit toward Degree or Certificate

Yes No Not for Dept. Majors Other

Only for credit by joint permission from SEF Program Committee and the Home Department (if appropriate) of the student.

Day	Topic(s)
1	**Pretest & Introduction to climate science**
2	**Earth's Energy Budget**
3	**The Carbon Cycle**
4	**Climate variability, natural causes**
5	**Climate variability, anthropogenic causes**
6	**Paleoclimatology**
7	**Introduction to mathematical models**
8	**Climate Models**
9	**Anthropogenic climate change; Mitigating our impact**
10	**Final project presentations & Final exam**

Textbook(s) or References

- Burroughs, William James, Climate Change a Multidisciplinary Approach, 2007.
- Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), The Physical Science Basis, 2007.

Mode of Delivery Class Online Modules **Other: Mixed (Class, Online)**

Program/Department Ownership: Science & Engineering Foundations for Education Program – School of Engineering & Science

Department Point of Contact and Title: Professor Greg Bartus, CIESE

Date approved by individual school and/or department curriculum committee: 3/23/2011 by Graduate Course Committee

General: The course will be offered over a three week period via blended delivery of face-to-face classroom meetings and an online component in the order given below. The course will leverage existing materials (hands-on and curricular) developed by the Center for Innovation in Engineering and Science Education (CIESE) in the areas of Earth science, energy and systems, but at a deeper level of technical depth and rigor appropriate for a course of this nature and building upon material covered in course one (SEF 530) in the PISA2 sequence.

- Initial 3 hr pre-test followed by 3 hr face-to-face-meeting (F2F Session 1) with an optional 2 hr after class support session.
- Four days of 4 hr face-to-face meetings (F2F Sessions 2 – 5) with optional after class support.
- Five Days of Online Learning Activities and Homework comprised of 4 hrs online discussion and activities, and homework assignments
- Four days of 4 hr face-to-face meetings (F2F Sessions 7 – 9) with optional after class support.
- One 3 hr Final Exam on F2F Session 10