COURSE CONTENT

Date	May 2018
Academic Year	2018/2019
Study Year (if applicable)	Year 1
Course Code & Title	ES1007 Climate Change
Academic Unit	4AUs
Pre-requisites	ES1001 E2S2 Environment and Society

Course Description

Climate change is a difficult, contentious, and important issue. It will perhaps be the defining environmental issue of the 21st Century. This course aims to address the whole complexity of climate change as an issue, by bringing together the science, impacts, economics, abatement technologies, and policy solutions into one course. Through this course, we will address several important questions. What is the scientific basis for our understanding of climate change, and in what ways is that scientific basis uncertain? What changes in climate might we expect over the coming centuries? What would be the impacts of these changes in climate for human well-being and the natural world? What are the sources of emissions of greenhouse gases? What technologies exist or might be developed to allow us to slow climate change, and what international policy solutions might be necessary or preferred?

ES 1007 Climate Change
[Lectures: 26 hours; Tutorial: 26 hours; Academic Units: 4.0)

Learning Objectives

Students will be expected to show mastery of relevant concepts drawn from the Earth sciences, chemistry, physics, engineering, economics, and political science, and be able to explain the relevance of these concepts for our present understanding of human-caused climate change and for the viability of different proposed solutions.

Content

S/N	**Topic**
1	Climate change science: early discoveries, energy balance model with GHGs. Role of radiative transfer, an improved estimate of climate sensitivity
2	Greenhouse gases, Aerosol Radiative Forcing and the observational record of modern climate change, global atmospheric circulation. Climate modeling and climate change feedbacks: linking atmosphere, oceans, biosphere, and cryosphere
3	Inferring climate sensitivity from the modern record. Detection and attribution of climate change – are there fingerprints?
4	Introduction to Impacts– Impacts, adaptation, and vulnerability
5	The global energy infrastructure and GHG emissions, stabilization wedges Future technologies: carbon sequestration, biofuels, hydrogen, geoengineering
6	Impacts of climate change
7	Solutions to climate change
8	Adaptation and climate change
9	Integrated Assessment, Decisions under uncertainty, climate change politics
10	Improving models for climate impacts
11	Climate change and Singapore - what are we in for?
12	Climate change in an Asian political context.
13	Unsustainable earth- how do we change from here?

Learning Outcomes

By the end of this course, students will be able to:

- Explain and evaluate the evidence for human-caused climate change, in the context of historical climate change, as well as the relevant scientific uncertainties and possible evidence to the contrary.
- Explain and quantify the impacts of climate change on human well-being and the natural world, and evaluate means by which these impacts can be reduced (adaptation).
- Explain the human causes of climate change, including the sources of greenhouse gas emissions. Because energy consumption is central to greenhouse gas emissions, students will understand the global energy infrastructure in a historical context and evaluate technological options for reducing emissions.
- Apply quantitative analysis of concepts relevant for climate change, drawn from chemistry, physics, and economics, through class assignments problems.
- Critically evaluate the successes and failures of past national and international efforts to address climate change, and evaluate prospects for future management of climate change.

- Critically evaluate the issue of climate change from the perspective of individual nations
- Assess the communication of science and policy for climate change, as a successful or unsuccessful example of how science and policy can and should inform one another.

In completing this course, students will improve their abilities to read and understand research papers from several disciplines addressing climate change, and to apply concepts quantitatively. Students will also improve their abilities to communicate through in-class presentations, and to develop and test hypotheses through an individual research paper.

Student Assessment

Students will be assessed by:

1) 2 in-class quizzes 25%

2x 1 hour class quizzes examining learning outcomes for the lecture series (25%) -- The quizzes will assess the students understanding of topics covered during the lecture series. Each quiz is a structured quiz with short answer scenario based questions (2-3 paragraphs and schematic drawing) and long answer question (1 page with 2 to 3 figures) formats.

2) Individual class assignment on impacts 25%

Student should submit a referenced summary article of a potential impact of climatic change. The work should not exceed 6 pages (double spaced, 11 to 12 point font) not including bibliography, tables and figures. There should only be 6-8 key references. The article may be in the form of a letter to the editor.

3) Group presentations - perspectives of different stakeholders 20%

Each student will participate in a research project to be presented orally (groups to present 20 to 30 minute summary and discussion) and as a short written term paper. Each student will also write brief reviews (< 200 words per review) of the other students' oral presentations of their research projects. These reviews should summarize the main findings of the project and provide constructive criticisms. The reviews should be kept in the form of a journal or notebook and must be turned in the 3rd last week of classes.

4) Individual research paper 30%

Students will submit an individual research paper on climate studies that should not exceed 20 pages (double spaced, 11 to 12 point font) not including bibliography, tables and figures. Details of the structure and the style will be discussed in class.

Resources/Textbooks/References

Because understanding of climate change is moving rapidly, this course will make use of recent and primary sources in the literature, drawing heavily from some of the key articles in journals like Science and Nature. We will also use all 3 volumes of the Intergovernmental Panel on Climate Change Fifth Assessment Report, which assesses our current understanding of climate change. Individual articles will be posted on NTUlearn.

There is one required text:

John Houghton, Global Warming: The Complete Briefing, 4th Edition, 2009, Cambridge Univ. Press. ISBN-13: 978-0521709163