University of Glasgow | School of Physics & Astronomy

PHYS 4006
Energy and the Environment

Course Information Guide 2023-24

1 Course Details

PHYS 4006 Energy and the Environment is a level 4 Physics Honours course. It is an elective course for most BSc, MSci and MSc degrees, but is compulsory for the postgraduate MSc in Physics: Energy and the Environment. It is composed of 20 lectures, all given in Semester 1.

Lecturer:

Dr Pedro Parreira
Room 216a, Kelvin Building
pedromiguel.raimundoparreira@glasgow.ac.uk

Time and place: Normally Wednesdays at 12.00-13.00 and Thursdays 9.00-10.00

Recommended Text: David JC MacKay, Sustainable Energy – without the hot air, http://www.withouthotair.com/download.html (free to download)

Background Reading: William F. Ruddiman, Earth's Climate Past and Future (Freeman, 2013)

The Royal Society, Geoengineering the climate, Science, governance and uncertainty, (2009) https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/ 2009/8693.pdf (free to download)

John Andrews and Nick Kelly, Energy Science, principles, technologies, and impacts, (Oxford University Press, 2013)

Course notes will be made available on Moodle.

2 Assessment

The course will be assessed via an examination in the April/May diet (75%) and an energy-related case study (25%). It provides 10 H-level credits.

3 Required Knowledge

Students are expected to be familiar with the basic concepts of energy, dynamics, electricity, thermodynamics and radioactivity, covered in Physics 1 and Physics 2. Estimation and problem solving will be important in this course and students are expected to have previous experience of these skills. This course may have some minor overlap with PHYS 5038 Nuclear Power Reactors and PHYS 5037 Environmental Radioactivity.

4 Intended Learning Outcomes

By the end of this course students will be able to demonstrate basic understanding of the physical principles involved in relevant energy sources (fossil, nuclear fusion and fission, wind, photovoltaic, hydroelectric, wave, geothermal etc.). They should be able to evaluate the advantages and disadvantages of the various energy sources. Students should be able to identify potential energy saving methods and to suggest improvements in energy efficiency of any specific system (from a single building to a whole country). They should also be able to describe the relation between energy production/consumption and any potential climate change. Students should be able to apply objective tackling methods for 'hardly-solvable' problems, focusing on scientific aspects, but also taking financial, ethical and political constraints into account (trade-off techniques).

5 Course Outline

This course will explore the underlying physical mechanisms of various methods of energy production, the principles of energy consumption and efficiency and their influence on environment and climate. The course will equip future physics graduates with a solid foundation in key physical principles and ideas that underpin climate change science and sustainable energy.

5.1 Fundamentals of Climate Change

We will study a range of atmosphere and climate models. We will review climate reconstruction, trends in climate parameters and discuss the role of greenhouse gases.

5.2 Physical basics of energy sources

We will identify, categorise, analyse and discuss a wide range of energy sources including fossil fuels (oil, gas, coal), nuclear power (fission and fusion), wind power, solar power (photovoltaics, thermal and biomass), hydroelectricity, wave, tidal and geothermal power.

5.3 Physical basics of energy consumption

We will identify, categorise, analyse and discuss a wide range of areas which consume energy including transport (cars, planes, freight), heating, cooling, light, food and farming, manufacturing and information systems.

5.4 Improving Energy Systems

We will discuss methods and techniques for improving energy systems including the issues of energy storage, energy transport and transmission, and energy efficiency.

5.5 Alternative Approaches

We will consider some new and unconventional approaches to the production of energy such as geo-engineering, and carbon capture and storage.

5.6 Prospects for sustainable energy in the UK and the rest of the World

Finally, we will look at the prospects for sustainable energy use in both the UK and the rest of the world, focusing on physical restrictions, political boundaries, ethical concerns and economical aspects.