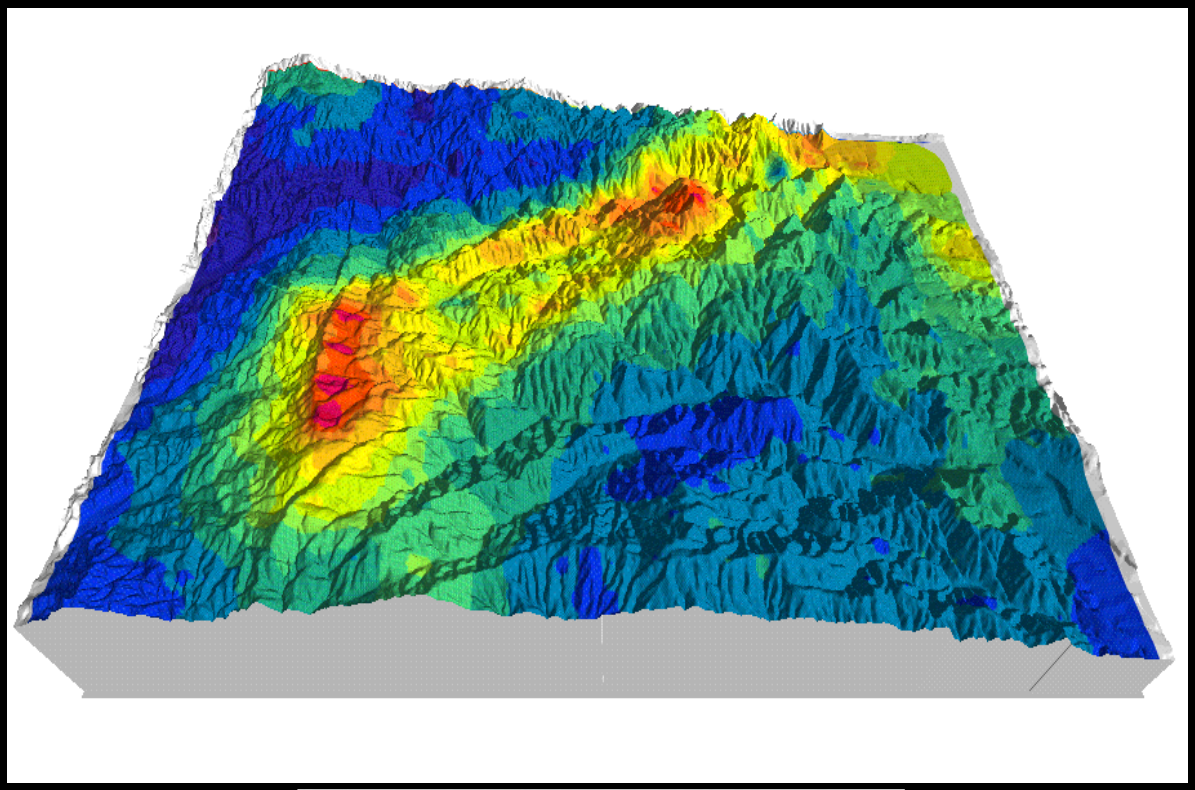
University of Glasgow | School of Physics & Astronomy



PHYS5037 Environmental Radioactivity

Course Information Guide 2023-24

1 Course Aims and arrangements

Environmental radioactivity whether of natural or anthropogenic origin provides the major source of ionising radiation exposure within the biosphere. Understanding the physical origins of radionuclides and their associated radiation are important to determining process rates in environmental systems, to analysis and modelling of radiation exposure, to dating geological and archaeological systems, and to impact and risk assessment of accidental or regulated releases to the environment. This course reviews the sources of environmental radionuclides, and their origins, distribution, and behaviour, from a physical science perspective. It aims to provide a physical basis for understanding dosimetry, scientific applications of radionuclides for chronometric and process tracing purposes, and to provide a framework against which the impact of accidental or routine releases of radionuclides from nuclear facilities can be placed with a context based on scientific understanding of existing sources of radiation within environmental systems.

PHYS5037 Environmental Radioactivity is a level 5 Physics Masters course. It is elective for many physics degrees. It is composed of lectures and tutorials given in semester 1, with further sessions dedicated to the critical study in semester 2.

Students are instructed on literature search techniques and management of bibliographic references. They use these in a critical study, presented orally to class in semester 2, and in written form as a research exercise, on a topic of their choice within the scope of the course.

Lecturer: Dr Alan Cresswell
SUERC, East Kilbride
Alan.Cresswell@glasgow.ac.uk

Course notes, problems sheets and selected supporting literature made available on Moodle.

2 Assessment

The course will be assessed via a critical study report (50%), an associated oral presentation (25%) and marked online problem exercises (25%). It provides 10 M-level credits.

3 Required Knowledge

Students should have reached a level in their physics study appropriate for entry to a Master level course. Familiarity with modern physics and a general understanding of atomic and nuclear structure are expected, as are problem solving skills and familiarity with the mathematical basis for solving differential equations.

4 Intended Learning Outcomes

By the end of this course students will be able to: explain the main sources and origins of environmental radioactive from a physical science perspective, explain the concept of radiation dose and the composition and dynamics of radionuclides in the environment, debate the impact of nuclear technology on environmental systems and the basis for regulation of future activities with potential releases to the environment.

They will also have gained experience of literature search, and of constructing and presenting evidence-based arguments.

5 Course Outline

5.1 Radioactive decay and sources of environmental radioactivity

Introduction to the history and discovery of radioactivity. Modes of radioactive decay. Nuclear binding energies and nuclear stability. Nuclear abundance. Sources of radioactivity in the natural environment. Primordial nuclides, cosmogenic nuclides, and anthropogenic nuclides. Decay laws, equilibrium, disequilibrium, and transient equilibrium. The natural decay series – a brief history and introduction to disequilibrium in environmental systems.

5.2 Ionising radiation and radiation dosimetry

Radiation units and measurements. Dosimetric concepts and quantities. Dose equivalent units and concepts. The relationships between infinite matrix dose rates, radionuclide concentrations and nuclear data. Measurement and calibration of analytical and dosimetric systems. Radiometric and radiochemical methods for determining environmental radionuclides. Alpha, beta and gamma spectrometry and radiometrics. The use of mass spectrometry and accelerator mass spectrometry.

5.3 Natural Radioactivity and its environmental distribution

Concentrations and dose rate contributions from primordial and cosmogenic radionuclides. Typical concentrations in terrestrial, and aquatic systems. Geological and land cover associations. Variations in the built environment. Naturally occurring radioactive material and industrial concentrations (NORM). Radon and radon decay products.

5.4 Anthropogenic Contributions

Fission and activation products associated with nuclear weapons, weapons' testing and the nuclear fuel cycle. Nuclear accidents: history, and source terms from past accidents. Local and global impacts. The dosimetric impact. Radioactive waste and its future committed activity distribution.

5.5 Scientific applications of environmental radioactivity

Radiogenic and radiation damage dating methods. The use of unsupported radionuclides to assess environmental transfer factors and process rates.