10708 - 718 (8) Radiation Interaction (1.5L, 1.5Pp)

2020

Course summary:

Radiation sources, the process of radioactive decay as source of radiation, interaction of photons and neutrons with matter, isotope production with reactors and accelerators, nuclear fission as a source of radiation, lasers and microwaves as sources of radiation.

Module relevance in programme:

This is a compulsory module for Physics students enrolled in the Honours programme in Radiation and Health Physics. On successful completion of this programme students are eligible for entry into a two-year internship in Medical Physics at an academic hospital in South Africa. Successful completion of the internship students is a prerequisite to becoming registered Medical Physicist with the Health Professions Council of South Africa (HPCSA).
The topics covered in this module relate mainly to how ionizing radiation can be created and how this radiation interacts with matter resulting in energy deposition and in some cases induced radioactivity.
The knowledge gained by students in this module will be applicable to their future day-to-day activities as a Medical Physicist working in a hospital or specialist consulting rooms where ionizing radiation is used.

Outcomes of course:

The aim of the course is to indicate useful, purposeful, safe and innovative application of radiation. It is a core module for advanced courses in medical physics and radiation applications in industry.

Lecturer:

Prof RT Newman
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Mentor:

The Department of Physics has appointed a staff member as mentor for each year of its physics programme to be available to students for consultation. Students should feel free to discuss general issues related to the physics programme or specific modules in the programme with the relevant mentor, in addition to usual consultations with their individual lecturers of modules.

The mentor for the Honours programme and its modules is **Dr CM Steenkamp** cmsteen@sun.ac.za.

Course content:

Formal lectures
The contents of the course is structured, if possible, to accommodate the background and/or special needs of the students.

1. **Radiation sources.**
   Units and definitions, Fast electron sources, Heavy charged particle sources, Sources of electromagnetic radiation, Neutron sources.

2. **The process of radioactive decay as source of radiation.**
   Radioactive decay series; Differential equations; "Bateman-equations"; Biological losses and radioactive decay; Effective half-life, Production of radioactive isotopes.

3. **Interaction of photons and neutrons with matter.**
   Emphasis is placed on energy transfer to the matter through which the radiation passes. Gamma-rays, neutrons.

4. **Isotope production with reactors and accelerators.**
   General equation for production / decay of radioactive isotopes.

5. **Nuclear fission as a source of radiation.**
   Process applications: Reactors; Criticality accidents

6. **Lasers and microwaves as sources of radiation.**

Practical and Tutorials:

A number of tutorials linked to homework exercises will be arranged.

Study material:

There is no prescribed handbook; reference is often made to:

- WR Leo, ***Techniques for Nuclear and Particle Physics Experiments***
- GF Knoll, ***Radiation Detection and Measurement***

Other useful sources are

- JE Martin, ***Physics for Radiation Protection***
- KS Krane, ***Introductory Nuclear Physics***
- FH Attix, ***Introduction to Radiological Physics and Radiation Dosimetry***.
- H Cember, ***Introduction to Health Physics***
- RD Evans, ***The Atomic Nucleus***
- CM Lederer et al. ***Table of Isotopes***
- E Segré, ***Nuclei and Particles***
- HE John, ***The Physics of Radiology***
- EB Paul, ***Nuclear and Particle Physics***
- Translation: RF Peierls, ***Kinematics of Nuclear Reactions***

Learning opportunities:

- Lectures
- Homework exercises and associated tutorials
- Mini-symposium
- Research for essay

Assessment:

Methods of Assessments

The students are evaluated continuously by means a number of homework exercises, presentation at a mini-symposium, an essay, and a written examination.
[Note: In order to obtain entry into the training internship to become a qualified Health Physicist, an examination that contributes at least 80% of the final performance mark in the module is required.]

Venue and time of assessment opportunities

This will be communicated at the start of the module.

Availability of marks

Within two weeks after the assessment opportunity

Calculation of final mark for the module

See the requirements in **Methods of Assessment** above.