Course-PM 2023

Radiation Protection, Dosimetry, and Detectors (SH2603), 6 hp

The course starts on August 28, 2023, 10.15-12.00, in room FA32, Albanova, KTH.

Course Code: SH2603
Credits: 6 hp
Level: D
Grades: A,B,C,D,E,F,Fx
Language: English

Compulsory Course the Master Programme in Nuclear Energy Engineering

The course is scheduled in Period 1 (Late August+September+October)
Lectures: 16 hours (8*2 hours)
Problem Solving Exercises: 14 hours (7*2 hours), but 4 hours will be used for mini-exams.
Lab. Exercises: 20 hours, 4*5 hours

Course Coordinator/Lecturer/Examiner
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Updated course information will be found in Canvas, the learning management system used at KTH.

Prerequisites

A background in mathematics+physics including a basic knowledge in modern physics, corresponding to a Bachelor of Science is required.

Course Objectives

This is a course in radiation physics with basic theory and applications in detection of ionizing radiation, radiation protection, and dosimetry.

The course is designed as a preparatory course for other courses in the neighbouring fields, preparing the student both for laboratory exercises where radioactive sources are used, and for solving problems involving basic radiation physics and radiation protection elements.

A main learning objective for this course is that the student should be able to use the acquired knowledge in nuclear- and radiation physics as a tool for calculating and estimating the dose absorbed in the human body from exposure to radioactive material in a wide range of situations. Together with a basic understanding of the interaction between matter and radiation, the biological effects of radiation, and knowledge about the current regulations on radiation protection, the student will be able to use these tools to make adequate choices for radiation protection in situations that will occur in their future courses, and in their future professional career.

To pass the course, the student must be able to:

- describe the basic parts and general attributes of the atomic nucleus.
- explain the origin of alpha- beta- and gamma radiation and give a examples of the origin of neutron radiation.
- explain how ionizing radiation of the above types interact with matter, and be able to apply this knowledge when designing radiation protection in various circumstances.
- give a few examples of radioactivity in nature and explain the origin of the radiation.
- explain the principles for detecting radiation of the various types, and be able to apply this knowledge for measuring radiation from radioactive materials.
- give an account for the basic regulations of dose limits, and be able to apply these rules for work in the laboratory as well as in the field.
- estimate, using calculations, the full body dose, from exposure of various radioactive sources, and from the results make adequate choices for the design of radiation protection.
- present, orally and in writing, results from lab measurements, calculations, and project studies, within the subject of the course.

For a higher grade, you must be able to solve more complex problems where the above objectives are applied.

Examination

The examination is formally divided in three parts:

- Laboratory exercises (attend lab exercises, write/pass lab. reports). Grade: pass/fail.
- Project (perform project in groups, attend presentation seminar, write/pass report). Grade: pass/fail
- Written Exam. Grade: A-F. The written exam (5 hours) will take place after the course, on October 20, 2023, 08.00-13.00. It consists of two parts, A and B. Both parts must be passed. The course grade reflects the total score of the written exam. In case a student fails the written exam, a re-exam is scheduled on December 18, 08.00-13.00.
  (In contrast to course rounds 2021 and 2022, no mini exams will be given during the course for the 2023 course round.)

Quizzes

Online quizzes is a feature that we first introduced in 2021 and will continue in 2023. The results on the quizzes have no formal consequence for your grade, and you can take each quiz as many times you want, until you are confident that you understand the problems well. You are encouraged to discuss any difficulty that you encounter with both teachers and fellow students. The quizzes is designed as a way to test your knowledge continuously during the course, as a complement to lectures and problems-solving exercise classes.

Contents

The contents of the course are focused on ionizing radiation, its origin and effects.

Theoretical models of the atomic nucleus, giving basic understanding of the various radiation types, will be only briefly discussed. In connection to that, the basic building blocks and attributes of the nucleus are described. The basic models for the interaction between radiation and matter will be discussed in some detail. The effect of radiation on the human body is treated briefly.

The knowledge from the parts above is then applied when discussing dosimetry and radiation protection. The basic units of dosimetry are introduced, as well as the current regulations for radiation protection, e.g. dose limits, when working with radioactive material.

In the student laboratory, the students will measure the effect of various types of radiation as they interact with matter. These radiation types include gamma rays, alpha particles, beta electrons, and neutrons. Reports of high quality should be written by the students, presenting their results in the lab.

Schedule

The current schedule is published in the KTH online scheduling system.

A lecture plan with some information about lecture content is available (for students registered to the course) in KTH/Canvas.

The schedule for the laboratory exercises will be presented/updated (also in Canvas) some time after the course starts, since it depends on the number of course participants.

Lectures

The course includes about 16 hours of lectures (8 lectures, 2 hours each).

Problem Exercises

The course includes 10 hours of class room problem exercises where you have the opportunity to practice problem solving and perform calculations of e.g. activity, radiation dose, and radiation protection design. A teacher will be present during these exercises, but the focus is on students solving the problems themselves.

The students are responsible for printing out their own copies of the problem exercises (available as a pdf file in Canvas), and to bring them to class to work on (or, alternatively, students can bring their laptop computer to class). In addition, the relevant reference materials needed should also be printed and brought to class. The teacher will supply the *Nuclide Chart* and the *Table of Isotopes*.

Laboratory exercises

There are four laboratory exercises (more information/instructions in the Canvas pages). Each lab take approximately 4-5 hours in the lab. After attending each lab. exercise, a lab. report is to be submitted in Canvas and will be read/corrected by the lab. assistant.

- Alpha/Spontaneous Fission lab.
- Gamma lab.
- Beta lab.
- Neutron activation lab.

Project Task

A project task is performed in groups of four students.The students are responsible of forming project groups, and of selecting a suitable project subject to be suggested to the examiner before staring the project work.

At the end of the course, the project is to be presented orally in class on the project seminar day. In addition, the project should be presented in a report, to be handed in (submitted to Canvas) on the seminar day.

The project should be related to the course content, but can be of many different types. Examples of project tasks from previous years can be fount in the list below.

Examples of subjects (selected project titles of students of 2007-2023):

- Build your own ionization chamber
- Build your own cloud chamber
- Build your own semiconductor detector
- Neutrons and BNCT
- Using music CD:s as alpha particle detectors
- Radon measurement indoors, using activated carbon
- Measurements of background radiation with a mobile detector
- Measurements of radioactivity in mushrooms from different sites in Europe
- Measurement of angular distribution of cosmic radiation
- Measurement of Sr90 activity in mushrooms, using beta spectroscopy
- Measurements of traffic induced effects in air activity at a metro station in Stockholm
- Building a Scintillator from cheap material

- The Chernobyl accident 1986
- A study on background radiation
- A study of the dose rates at high altitudes
- Measurements of radioactivity in mushrooms

Project Presentation Seminar

A project seminar day is planned on O**ctober 10, 2022, 08.00 (sharp!)-10.00, Albanova FA32.** The projects should be presented by one person from the group, and that person is randomly selected by the course coordinator just before the presentation, so all students in the group should be prepared to perform the presentation. Each presentation should take around 10 minutes (exact time depends on the number student groups). A more detailed schedule will be presented a few days before the seminar day. Participation in the seminar day is compulsory for all students to pass the project part of the course.