PHY4275: RADIOLOGICAL PHYSICS AND DOSIMETRY

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Radiological Physics and Dosimetry

Subject Code
PHY - Physics
Course Number
4275

Academic Unit
Physics (PHY)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
AP4275 Radiological Physics and Dosimetry

Exclusive Courses
Nil

Part II Course Details

Abstract

The present course aims to teach the students about the basic physical principles that form a common foundation for radiotherapy physics, diagnostic radiological physics, nuclear medicine and health physics. The course materials mainly cover the concepts related to the science of ionizing radiation, the quantitative determination of absorbed dose, clinical applications of radiation and radiological equipments used in medicine, which are essential to understanding of the practice in medical radiation physics.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the origin and nature of ionizing radiation.		x		
2	Describe the interaction of different types of ionizing radiation with matter.		x		
3	Explain the principles of clinical radiological equipment.			x	
4	Relate the operation principle and properties of radiation detectors to their usage in clinical environments.			x	
5	Apply the principle of radiation dosimetry.			x	

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Including teaching of lecture materials, tutorial and problem solving sessions	1, 2, 3, 4, 5	2 hours/week

2	Tutorials	Questions and answers sessions, during which students will be asked questions and can ask questions, and there will be time for discussion. Numerical problems will also be given to the students to solve. If needed, the lecturer and/or TA will give information or hints to help the students solve the problems.	1, 2, 3, 4, 5	1 hour/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Assignments	1, 2	10	
2	Mid-term test	1, 2, 4	20	

Continuous Assessment (%)

30

Examination (%)

70

Examination Duration (Hours)

2

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained

Assessment Rubrics (AR)

Assessment Task

1. Assignments

Criterion

The student completes all assessment tasks/activities and the work demonstrates excellent understanding of the scientific principles and the working mechanisms for radiological physics and dosimetry.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)
Not reaching marginal level

Assessment Task
2.Mid-term Test

Criterion
The student can thoroughly identify and explain how the principles are applied to science and technology for radiological physics and dosimetry problems.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not reaching marginal level

Assessment Task
3. Exam

Criterion
The student can thoroughly identify and explain how the principles are applied to science and technology for radiological physics and dosimetry problems.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not reaching marginal level

Part III Other Information

Keyword Syllabus

- Atomic and nuclear structure
  Properties of elemental particles, atomic structure and energy levels, radioactivity, particle radiation and electromagnetic radiation, inverse square law.
- Origin and properties of radiations
  Types and sources of ionizing radiation, radioisotopes and different modes of radioactive decay, radioisotope production, x-ray production, x-ray generators, particle accelerators, principles of commonly used radiological equipment used in medicine, including x-ray unit, CT scanner, SPECT, linear accelerator, cyclotron.
- Basic radiation biophysics
  Effects of radiation on cells and molecules, effects on human, stochastic effects, deterministic effects, radiation dose response, factors affecting radiosensitivity.
- Applications of radiation
  Clinical applications of radiation and radioisotopes, therapy, imaging, in-vivo and in-vitro diagnostic applications, industrial applications.
- Quantities and units of ionizing radiations
  Quantities and units that are used in the field of ionizing radiation, such as kerma, absorbed dose, exposure, and those for use in radiation protection.
- Interaction of radiation with matter
  Gamma and x-ray interaction with matter, charged particle interaction with matter, neutron interactions, attenuation, transmission, absorption, HVL, TVL.
- Radiation dosimetry and measurement methods
  Working principles of radiation detectors, including ionization chambers, thermoluminescent dosimeter, film, solid state detectors, calorimeter and chemical dosimeter, general characteristics of different counters, monitors, and dosemeters and their application in the clinical environment, radiation counting systems, room survey and monitoring systems, personal monitoring, exposure and dose measurements, low level and high level radiation measurements, calibration of radiation monitors.
- Absolute dose measurement
  Free air ionization chamber, cavity theory, derivation of absorbed dose to water using calibrated ionization chamber, derivation of absorbed dose in medium other than water, equipment used for absolute dose measurements, high level and low level measurements, dosimetry protocols, measurement standards and traceability, other absolute dose measurement systems and methods, measurement errors and uncertainties.
- Relative dose measurement
  Photon and electron measurements such as percentage depth dose, tissue air ratios, backscatter factor, output factors and beam profiles. Relationship between some of the above dosimetric quantities.

Reading List

Compulsory Readings

	Title
1	Frank Herbert Attix, "Introduction to Radiological Physics and Radiation Dosimetry", Wiley-VCH, 2004.

Additional Readings

	Title
1	Harold Elford Johns and John Robert Cunningham, "The physics of radiology", Fourth edition, Charles C Thomas: Springfield, Illinois, USA. 1983.