Course Specification

(Postgraduate Programs)

Course Title:	Radiation Detection and Measurements
Course Code:	PHY 6273
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University
Version:	3
Last Revision Date:	*26/09/2024*

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A. General information about the course:

1. Course Identification:

1. Credit hours: 3				
2. Course type				
A.	☐ University	☐ College	☒ Department	☐ Track
B.	☐ Required		☒ Elective	
3. Level/year at which this course is offered: Level 3 or 4/Year 2				
4. Course General Description:				
This course is intended to develop and apply the measurement related to Radiation Physics, Nature of Counting Distributions, Binomial Distribution, Poisson Distribution, Normal Distribution, Mean and Standard Deviation of a Set of Measurements. The course starts with Units of measurement and Detection and Uncertainty for Gamma Spectroscopy and discussed the levels of Detection, Critical Level, Detection Limit (Ld) or Lower Level of Detection (LLD), Minimum Detectable Concentration or Contamination, Minimum Detectable Concentration (MDConc.), Minimum Detectable Contamination (MDCont.), Less-than Level (Lt), Interpretations and Restrictions, Log Normal Data Distributions, Particle Size Analysis.				
5. Pre-requirements for this course (if any): None				
6. Pre-requirements for this course (if any): None				
7. Course Main Objective(s):				
At the end of this course, students will be able to: • **Demonstrate and understand the principles of radiation detection and measurement in nuclear instruments;** • **Understand the theory, design, and operation of the most common radiation detection instruments.** • **Evaluate and compare the radiation instrumentation methods.** • **Gain knowledge and skills on radiation detection, counting and spectrometry including shielding and health physics;** • **Develop a working knowledge of error analysis and statistical methodology to be used in the design of experiments and the quantification of radioactivity.** • **Understand the applicability and limitations of all major types of detectors.**				

- **Demonstrate an ability to conduct experiments and understanding how to acquire, identify, quantify and assess radionuclides and report radiation data, uncertainty and detection limits.**
- **Gain a thorough understanding of gamma and neutron spectroscopy and the systems used in multichannel analysis.**
- **Have the opportunity to understand the techniques to solve, through discussion and reading, a wide range of specific theoretical problems, including their backgrounds and implications;**
- **Be adept at the application of physical and mathematical tools to solve real life problems in the considered domain.**

2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		
4	Distance learning		

3. Contact Hours: (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	**30**
2.	**Laboratory/Studio**	**0**
3.	**Field**	**0**
4.	**Tutorial**	**30**
5.	**Others (specify)……**	**0**
	Total	**60**

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods:

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Describe the naturally occurring radioisotopes, physical phenomena.**	**K1**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	**Interpret the principles of radiation detection and measurement in nuclear spectroscopy**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Define the applicability and limitations of all major types of detectors.**	**K1, K3**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	**Discuss the neutron interaction with matter and how can it detected.**	**K1, K3**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. Quizzes.
2.0	**Skills**			
2.1	**Explain and summarize the basic knowledge gained from studying radiation detection and measurement.**	**S1, S2**	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	**Develop the students ability to solve and analyze problems in physics related the topics covered by the course.**	**S2, S3**	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	**Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.**	**S3, S4**	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
3.0	**Values, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework. ▪ Mini-project(s).

C. Course Content:

No	List of Topics	Contact Hours
1.	**General Properties of Radiation Detectors: Simplified detector model, Models of detector operation, Pulse height spectra, Counting curves and plateaus, Energy resolution, Detection efficiency, Dead time.**	**8**
2.	**Ionization Chambers: The ionization process in gases, Charge migration and collection, Design and operation of DC ion chambers, Pulse mode operation.**	**8**
3.	**Proportional Counters: Gas multiplication, Design features of proportional counters, Proportional counter performance, Detection efficiency and counting curves, Variants of the proportional counter design.**	**8**
4.	**Geiger-Mueller counters: The Geiger discharge, Fill gases, Quenching, Time behavior, The Geiger counting plateau, Design features, Counting efficiency, Time-to-first count method, G-M survey meters.**	**8**
5.	**Scintillation Detectors: Organic scintillators, Inorganic scintillators, Light collection and scintillator mounting.**	**6**
6.	**Photomultiplier Tubes and Photodiodes: The photocathode, Electron Multiplication, Photomultiplier tube characteristics, Photodiodes as substitutes for photomultiplier tubes, Scintillation pulse shape analysis, Photoionization detectors.**	**6**
7.	**Semiconductor Diode Detectors: General consideration in gamma-ray spectroscopy, Gamma-ray interactions, Properties of scintillation gamma-ray spectrometers.**	**6**
8.	**Germanium Gamma-Ray Detectors: General consideration, Configuration of germanium detectors, Germanium detector operational characteristics, Gamma-ray spectroscopy with germanium detectors.**	**6**
9.	**Neutron Detection and Spectroscopy: Nuclear reactions of interest in neutron detection, Detectors based on the boron reaction, Detectors based on other conversion reactions.**	**4**

Total	60

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Class Activities (class quizzes, homework, solving problems, etc.....)	weekly	20 %
2.	Midterm Exam 1	6th week	20 %
3.	Midterm Exam 2	12th week	20 %
4.	Final Exam	16th week	40 %

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

E. Learning Resources and Facilities:

1. References and Learning Resources:

Essential References	*-G.F. Knoll, Radiation Detection and Measurement, 4th Edition, John Wiley & Sons, 2012*
Supportive References	*-E.J. Turner, Atoms, Radiation, and Radiation Protection, 3rd Edition, Wiley-VCH Verlag GmbH & Co., KGaA, Weinheim, 2007.* *-G.R. Gilmore, Practical Gamma–ray Spectrometry, 2nd Edition, John Wiley & Sons, Ltd., 2008.*
Electronic Materials	https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx
Other Learning Materials	Multimedia associated with the textbook and the relevant websites.

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	- Classrooms
Technology equipment (Projector, smart board, software)	- Classroom equipped with a whiteboard and a projector.
Other equipment (Depending on the nature of the specialty)	

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	- Students. - Second examiner	Indirect (The student will complete evaluation forms at the end of semester. Final exam is evaluated by the second examiner)
Effectiveness of students' assessment	- Instructors	Direct (exams, HW, project, ...)
Quality of learning resources	- Faculty - Students	Indirect (surveys)
The extent to which CLOs have been achieved	- Instructors - Program Leaders	Direct (excel sheet)
Other		

Assessor (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 6
DATE	26/09/2024