Course Specification

(Postgraduate Programs)

Course Title: Radiation Detection and Measurements
Course Code: PHYS 632
Program: Master of Science in Physics
Department: Physics
College: College of Sciences
Institution: Majmaah University
Version: I
Last Revision Date: 30/12/2024

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: (3)					
2. Course type					
A.	☐University	☐College	☒ Department	☐Track-1	☐Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: (Level 3/ year 2)					
4. Course general Description:					
The course provides theoretical knowledge of ionizing radiation detection and measurement techniques. The course covers the measurement of small currents and charges, pulse-height analysis, statistics, and dead-time corrections. Gas, scintillation, and semiconductor detectors, as well as neutron detectors, will also be studied to understand radiation detection techniques. The course also covers gamma and alpha/beta spectrometric techniques, as well as dosimeter and calorimeter detectors.					
5. Pre-requirements for this course (if any):					
Radiation Physics and Dosimetry, PHYS 622					
6. Co-requisites for this course (if any):					
N/A					
7. Course Main Objective(s):					

The main objectives are as follows:

- Demonstrate an understanding of the principles of radiation detection and measurement, as well as the use of nuclear instruments.
- Gaining knowledge and skills in radiation detection, counting, and spectrometry, including shielding and health physics, as well as radioactive sample preparation for analysis.
- Demonstrate an ability to understand how to acquire, identify, quantify, and assess radionuclides and report radiation data, uncertainty, and detection limits.

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	3	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**	45
2.	**Laboratory/Studio**	
3.	**Field**	
4.	**Tutorial**	
Total		**45**

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

Code	Course Learning Outcomes	Code of PLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	Understand the role of fundamental processes involved with the interaction of X-rays and gamma-ray photons, charged particles, and neutrons with matter.	**K1**	Lectures Teamwork Discussions Exercises Quizzes Problem-solving	Exams Quizzes Homework Assignments
1.2	Detailed knowledge of the principles of operation of solid-state semiconductor detectors, scintillation counters, and gas ionization detectors.	**K4**	Lectures Teamwork Discussions Exercises Quizzes Problem-solving	Exams Quizzes Homework Assignments
2.0	**Skills**			
2.1	Collect general information about radiation detection and techniques of measurement.	**S1**	Lectures Teamwork Discussions Exercises Quizzes Problem-solving	Exams Quizzes Homework Assignments
2.2	Use mathematical equations to understand particle interactions.	**S3**	Lectures Teamwork Discussions Exercises Quizzes Problem-solving	Exams Quizzes Homework Assignments

2.3	Apply the gained mathematical and experimental knowledge to any physics-related topics.	**S3**	Lectures Teamwork Discussions Exercises Quizzes Problem-solving	Exams Quizzes Homework Assignments
3.0	**Values, autonomy, and responsibility**			
3.1	Work effectively both independently and in groups.	**V3**	Class discussion	Supervisor evaluation
3.2	Present a short report in written form and orally using appropriate scientific language.	**V3**	Class discussion	Internal evaluation

C. Course Content

No	List of Topics	Contact Hours
1.	Radiation sources, interactions of particles (Heavy charged particles, electrons, neutrons, Gamma rays) with matter, Radiation Exposure and Dose	**6**
2.	General properties of radiation detectors: Simplified Detector Model, Modes of Detector Operation, Pulse Height Spectra, Counting Curves and Plateaus, Energy Resolution, Detection Efficiency, and Dead Time.	**6**
3.	Counting statistics and error analysis: Characterization of data, Statistical models, Applications of statistical models, Limits of detectability, Distribution of time intervals.	**6**
4.	The action of a gas-filled ionization chamber and proportional counters, gas multiplication; ion mobility, recombination, pulsed and direct current modes of operation; Geiger-Muller counter, internal and external quenching, practical devices	**6**
5.	Scintillation counting with gases, liquids, and solids; theory of operation, selection for various applications.	**6**
6.	Semiconductor detectors (HPGe detector), Configurations of Germanium detectors, Germanium detector operational characteristics, Gamma-Ray spectrometry technique.	**5**
7.	Dosimeters, calorimeters, chemical dosimetry, gas dosimetry, W-values, and stopping power ratio.	**5**
8.	Neutron activation, Neutron detection, fission track detectors, neutron spectrometry.	**5**
Total		**45**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Quizzes	4	10
2.	Homeworks	6	10
3.	Oral presentation	8	10
4.	Midterm 1	7	15
5.	Midterm 2	11	15
6.	Final Exam	16	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	• **Radiation Detection and Measurement;** 5th edition, Glenn F. Knoll, John Wiley & Sons, Inc., New York, 2020. • Measurements and Detection of Radiation, 3rd edition, Nicholas Tsoulfanidis and Sheldon Landesberger. CDC Press, 2013 (ISBN: 978-1-4200-9188-5). • **Introductory Nuclear Physics**; K.S. Krane, 2nd edition, John Wiley and Sons, 1988.
Supportive References	• UNSEAR 2008 Report. Vol 1: Sources and Effects of Ionizing Radiation. • ICRP 2013 Report. International Commission on Radiological Protection. • Radiation Measurements Journal
Electronic Materials	• Saudi Digital Library (SDL) • https://www.wikipedia.org/ • Web of Knowledge • Physics Today (web version) • MIT Courseware • www.eagle.co.uk/news/ppnews.html • http://faculty.mu.edu.sa/mskhan • http://vlib.org/physics.html • http://dir.yahoo.com/science/physics • http://demonstrations.wolfram.com • http://askthephysicist.com • http:// cyberphysics.co.uk • Online Courses and Lectures: Platforms like Coursera, edX • Khan Academy may have relevant courses.

Other Learning Materials	• J. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment. (NIM A) • Radiation Physics and Chemistry Journal • Excel software for drawing graphs. • MS Office for writing reports and presentations.

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Lecture room with at least 25 seats.
Technology equipment (projector, smart board, software)	A smart board.
Other equipment (depending on the nature of the specialty)	Library, Seminar Room, and Wi-Fi internet connections.

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students/ internal committee	Direct
Effectiveness of Students' Assessment	Staff members (Peer Reviewer)	Indirect
Quality of learning resources	Staff members (Peer Reviewer)	Indirect
The extent to which CLOs have been achieved	Staff members (Peer Reviewer)	Direct

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

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Physics Department
REFERENCE NO.	16
DATE	30/12/204