Course Syllabus — Radiation Detection and Protection (AES2071)

Credit Hours: 2 Credit hours

Prerequisites: Basic Atomic and Nuclear Physics (AES2021) and Electrical Engineering Technology I – DC (AES1041)

QFE Level: 6

Knowledge: Specialized factual knowledge and an understanding of the boundaries in a field of work or discipline, encompassing a broad and coherent body of knowledge and concepts, with depth in the underlying understanding of the principles and concepts. An understanding of allied knowledge and theories in related fields of work or disciplines and in the case of paraprofessional respective discipline including related regulations, standards, codes, conventions. An understanding of critical approach and analysis, research approaches and methods and analytical problem-solving techniques from a range of sources familiarity with sources of current and existing knowledge and the integration of concepts from related fields. Literacy to comprehend and/or produce coherent texts, covering complex and/or diverse relations from a wide range of information. Numeracy covering a wide-range of mathematical procedures and representations used across a broad-range of contexts.

Skills: Specialist technical, creative and conceptual skills appropriate to solving complex problems associated with a field of work or discipline. A comprehensive range of specialist cognitive and practical skills appropriate to planning and implementing solutions to varied, unpredictable and unfamiliar problems within a field of work or discipline. Selection and use of appropriate research tools and strategies associated with the field of work or discipline. Advanced communication and information technology skills to present, explain and/or critique interdependent complex matters. Literacy skills to comprehend and/or produce, from a wide range of information, coherent texts covering complex and/or diverse relations. Numeracy skills to select, apply, assess and communicate a wide range of mathematical procedures and representations in a broad range of contexts.

Competence:

Autonomy and responsibility: Can take responsibility for developing appropriate approaches to managing complex work procedures and processes, resources or learning, including leading teams within a technical or professional activity with little support. Can supervise technical, supervisory or design processes in varied, unpredictable, unfamiliar and a broad range of contexts. Can work effectively as a specialist or in team leadership roles. Can express an internalized, personal world view, reflecting engagement in society at large and in sociocultural relationships.

Role in context: Can function with full autonomy in technical and supervisory contexts and adopt paraprofessional roles under guidance. Can take responsibility for the setting and achievement of group outcomes and for the supervision of the work of others. Can take responsibility for supervising the development of individuals and groups. Can participate in peer relationships with qualified practitioners and lead multiple groups.

Self-development: Can evaluate own learning and identify learning weaknesses and needs, in a familiar and unfamiliar environment. Can take initiative to address learning needs and function independently and within learning groups. Can support and observe ethical standards.

AES2071 | Radiation Detection and Reactor Plant Safety

Course Description

This course covers radiation detection and protection theories and techniques needed for operation and maintenance of nuclear power plants. It defines and introduces basic concepts in radiation safety, dose limits, and risk. These include units of radiation dosimetry, calculation of internal and external radiation exposures, and protection from radiation hazards. The course also covers reactor plant protection and major industry operating accidents.

Instructors: TBD, TBD@adpoly.ac.ae

Schedule and Duration: 15 weeks plus examination week. 2 hours lecture/week.

Course Objectives

The overall objective of this course is to develop student understanding of radiation detection and measurement, radiation protection and basics of reactor plant safety. Students should be able to identify different types of radiation detectors, their applications in the industry, and explain the mechanism they use to detect radiation. Students should be able to identify radiation protection methods and explain how these methods are implemented to reduce and protect personnel from radiation exposure.

Textbook

1. ACAD Basic Curriculum, Instrumentation & Control, General Physics Corporation, Elkridge, Maryland, 2003.
2. Daniel A. Gollnick (Ed.), Basic Radiation Protection Technology, sixth edition, Pacific Radiation Corporation, 2011

References

1. Nawah, Radiation Measurement and Detection slides, NPP Training Update, Rev. 04, 2015
2. Herman Cember, Introduction to Health Physics, Fourth Edition, McGraw-Hill Medical, 2009.
3. Glen F. Knoll (Ed.), Radiation Detection and Measurement, Fourth Edition, John Wiley, 2010.

Attendance

Sessions start on the hour. Students arriving after the session starts will be counted absent. Students will receive warnings and potential penalties from the Student Services Office or their sponsor if they reach 5%, 10%, and 15% absence. After 15% absence, students will receive a FA (fail due to absence) grade.

Academic Honesty Policy

Students must conduct their studies at ADPoly honestly, ethically, and in accordance with accepted standards of academic conduct. Any form of academic conduct which is contrary to these standards is academic misconduct, for which ADPoly may penalize the student.

Specifically, it is academic misconduct for a student to:

- Present copied, falsified, or improperly obtained data as if it were the result of laboratory work, field trips, or other investigatory work;

- Include in the student's individual work material which is the result of significant assistance from another person if that assistance was unacceptable according to the instructions or guidelines for that work;
- Cheat or attempt to cheat; or
- Plagiarize (knowingly presenting the work or property of another person as if it were one's own)

Abu Dhabi Polytechnic considers cheating or attempting to cheat a serious offense that will result in disciplinary action taken against involved individuals. Students caught cheating or attempting to cheat will earn an "F" grade in the course.

Course Learning Outcomes (CLOs)

Upon successful completion of the course a student should be able to:

CLO 1: Demonstrate knowledge of control of radiation exposure and contamination fundamentals.

CLO 2: Demonstrate basic knowledge of radiation measurement fundamentals.

CLO 3: Demonstrate knowledge of radiation detector fundamentals.

CLO 4: Demonstrate the knowledge on counting statistics in radiation detection and measurements.

CLO 5: Demonstrate knowledge of radiation protection fundamentals.

CLO 6: Demonstrate basic knowledge of radiation dose standards, guides, limits and protection methods.

Course Topics

CT 1: Statistical Analysis: mean, mode, standard deviation, median, percent error, confidence level, precision and accuracy, distribution functions.

CT 2: Radiation Sources. Major sources of natural background radiation, man-made sources of background radiation, and radioactive sources routinely found in a nuclear plant.

CT 3: Radiation Detection and Monitors. Principles and operation of radiation detection and monitors including area radiation monitors, electronic dosimeters, gas-filled detectors, personnel dosimetry, personnel monitors, whole body monitors, process radiation monitors, and scintillation detectors.

CT 4: Radiation Effects. Radiation effects including the effects of radiation on matter and body tissues (somatic, genetic, acute and chronic).

CT 5: Radioactive Dose Calculations. Radioactive dose and matter, conversion of units (curies, roentgen, rems, rads), simple calculations to estimate dose, units of measurement.

CT 6: Exposure Control. Contamination, decontamination, exposure reduction methods, protective clothing and respirators, provisions of FANR regulations, radiologically controlled areas.

ABET Student Outcomes

The Higher Diploma in Nuclear Technology program student outcomes are taken from the ABET (Accreditation Board for Engineering and Technology, Inc.) 2019 Student Outcome 2 for associate degree programs and Student Outcomes 1, 3, 4, and 5 for baccalaureate degree programs. These are the following learned capabilities:

SO1. An ability to apply knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology to solve broadly defined engineering problems appropriate to the discipline;

SO2. An ability to design solutions for well-defined technical problems and assist with the engineering design of systems, components, or processes appropriate to the discipline;

SO3. An ability to apply written, oral, and graphical communication in broadly defined technical and non-technical environments; and an ability to identify and use appropriate technical literature;

SO4. An ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results to improve processes; and

SO5. An ability to function effectively as a member as well as a leader on technical teams.

Table 1: Relation Course Topics (CTs) to Course Learning Outcomes (CLOs)

	CT1	CT2	CT3	CT4	CT5	CT6
CLO1						H
CLO2			H			
CLO3			H			
CLO4	H					
CLO5		H		H		
CLO6					H	

H: High, M: Moderate, L: Low

Table 2: Relation Course Learning Outcomes (CLOs) to Students Outcomes (SOs)

	SO1	SO2	SO3	SO4	SO5
CLO1	H	M	M		M
CLO2	H	M	M		M
CLO3	H	M	M		M
CLO4	H	M	M		M
CLO5	H	M	M		M
CLO6	H	M	M		M
Average					

H: High, M: Moderate, L: Low

Week	Topic	Content	Textbook
1-2	Statistical Analysis	Counting statistics. Effects of background on radiation measurements, error propagation	[2] Chapter 12
2-3	Radiation Detection and Monitors	Interaction of radiation with matter: Alpha, beta, gamma and neutron	[2] Chapter 3
4-5	Radiation Detection and Monitors	Theory of radiation detection	[2] Chapter 7 [1] 1.1.8
5-6	Radiation Detection and Monitors	Gas filled detectors: Ion chambers, Proportional counters and GM tubes	[2] Chapter 7 [1] 1.1.8
7-8	Radiation Detection and Monitors	Scintillators, Gamma spectroscopy, solid state detectors and other detectors	[2] Chapter 7 [1] 1.1.8
8	Midterm Exam	Summative assessment covering material through first half of course	
9-10	Radioactive Dose Calculations.	Radiation units and limits and dose calculations	[2] Chapter 5 [1]1.1.8
10-11	Radiation sources	Natural and man-made sources and Radiation sources at a NPP	[2] Chapter 5 [1] 1.1.4
12-13	Radiation Effects.	Biological effects of radiation. Radiation effects on water, cells, human organs and whole body.	[2] Chapter 4 [1] 1.1.8
14-15	Exposure control	Shielding, distance, time and source term reduction	[2] Chapter 10-12 [1] 1.1.8
	Final Examination	Summative and comprehensive examination	