Course Syllabus — Reactor Plant Safety (AES2073)

Credit Hours: 2 Credit hours

Prerequisites: Basic Atomic and Nuclear Physics (AES2021)

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.

AES2073 | Reactor Plant Safety

Course Description

This course covers basic concepts in nuclear safety including reactor plant protection. The course also covers major industry operating experiences including a number of accidents.

Instructor: Hiba Al-Khodire

Schedule and Duration: 15 weeks plus examination week. 2 hours lecture/week. 1 hour of tutorial/week.

Course Objectives

The overall objective of this course is to develop student understanding of reactor plant protection concepts, design basis accidents, transient prevention, and core damage mitigation.

References

1. B.R. Sehgal, Nuclear Safety in Light Water Reactors, First edition, Academic Press, 2011
2. John R. Lamarsh, Introduction to Nuclear Reactor Theory, Third edition, Pearson, 2001.
3. -----, Lecture Presentations, ADPoly, 2020.

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.

AES2073 | Reactor Plant Safety

Course Learning Outcomes (CLOs)

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

CLO 1: Explain basic concepts related to reactor plant protection

CLO 2: Explain design basis accidents.

CLO 3: Explain transient prevention.

CLO 4: Explain core damage mitigation.

CLO 5: Summarize basic information about major industrial operating experiences.

Course Topics

CT 1: Nuclear Safety. Definition of Nuclear Safety. Risk and perception. Components of risk definition.

CT 2: Reactor Plant Protection. Administrative controls and procedural concepts, automatic reactor plant protection concepts, defense in depth, fission product barriers, limiting conditions for operation, and safety limits.

CT 3: Major Reactor Plant Operation Accidents. Three Mile Island Nuclear Station accident, Chernobyl Nuclear Power Plant accident, Idaho National Reactor Testing Station stuck rod accident, Browns Ferry Nuclear Plant fire, Idaho National Reactor Testing Station stuck rod accident, Davis-Besse Nuclear Power Station event, and Fukushima complete plant blackout accident.

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.

AES2073 | Reactor Plant Safety

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

	CT1	CT2	CT3
CLO1	H		
CLO2		H	M
CLO3		H	L
CLO4		H	L
CLO5		M	H

H: High, M: Moderate, L: Low

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

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

H: High, M: Moderate, L: Low

Assessments: Weekly problem sets, quizzes, midterm exam, and final exam

Grading policy:

Homework	10%
Quizzes	20%
Midterm exam	30%
Final exam	40%
Total	100%

Week-by-Week Teaching Plan

Week	Topic	Content	Reference
1	CT 1: Nuclear Safety	Definition of Nuclear Safety. Risk and perception. Components of risk definition.	[3] 1 Basic Concepts
2	CT 2: Reactor Plant Protection	Administrative controls and procedural concepts. Automatic reactor plant protection concepts. Defense in depth. Fission product barriers. Limiting conditions for operation. Safety limits.	[3] 1 Basic Concepts
3-4	CT 2: Reactor Plant Protection	Design basis accidents. Accident characterization, diagnosis, and mitigation.	[3] 2 Accident Analysis
5	CT 2: Reactor Plant Protection	Safety assessment and transient prevention. Safety systems and core cooling mechanisms.	[3] 3 Core Cooling Mechanisms
6	CT 2: Reactor Plant Protection	Core damage mitigation. EOP and SAMG.	[3] 4 Core Damage
7	CT 2: Reactor Plant Protection	Hazards during an accident. Radiation biology. Sources of radiation.	[3] 5 Hazards
8	Midterm Examination and Review		[3] 1-5
9	CT 3: Major Reactor Plant Operation Accidents	Three Mile Island Nuclear Station accident	[3] 6 TMI
10	CT 3: Major Reactor Plant Operation Accidents	Chernobyl Nuclear Power Plant accident.	[3] 7 Chernobyl
11	CT 3: Major Reactor Plant Operation Accidents	Fukushima Nuclear Power Plant accidents	[3] 8 Fukushima
12-13	CT 3: Major Reactor Plant Operation Accidents	Salem Generating Station turbine blade throw. Browns Ferry Nuclear Plant fire.	[3] 9 Other Accidents
14	CT 3: Major Reactor Plant Operation Accidents	Idaho Falls stuck rod accident, Davis-Besse Nuclear Power Station event	[3] 9 Other Accidents
15	Final Examination Revision		[3] All
	Final Examination	Summative and comprehensive examination	[3] All