City University of Hong Kong
Course Syllabus

offered by
Department of Mechanical Engineering
with effect from Semester A 2022 / 23

Part I Course Overview

Course Title:	Fundamentals of Nuclear Engineering
Course Code:	MNE8114
Course Duration:	1 semester
Credit Units:	3 credits
Level:	R8
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

Nuclear engineering is an extremely broad field, covering several professional aspects. The one-semester course of "fundamental of nuclear engineering" is aim to equip research students:

- With the knowledges of atomic and nuclear physics, interaction of radiation with matter, principles of fission reactors, nuclear reactor theory, and the development of advanced nuclear energy systems.
- With the ability to identify the neutron transport theory, diffusion theory, criticality calculations, reactor kinetics, neutron slowing down theory and numerical solution to the diffusion equation.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	**Learn** the nuclear physics and interaction of radiation particles with matter.	20		✓	
2.	**Describe** the principles of fission nuclear reactors and different types of nuclear power plants.	10	✓		
3.	**Identify** how the complex neutron transport and slowing-down processes can be described by simple analytical models.	30		✓	
4	**Demonstrate** the basic nuclear reactor theory, including one-group reactor equation, multi-group calculations and heterogeneous reactors.	30		✓	
5	**Study** the conceptual design of Generation-IV (Gen-IV) reactors and D-T fusion reactors.	10	✓		
** If weighting is assigned to CILOs, they should add up to 100%.*		100%			

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 self-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.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.					Hours/week (if applicable)
		1	2	3	4	5	
Lecture	Explain key concepts, principles, theories, and their applications in fundamentals of nuclear physics, nuclear reactors and nuclear power plants, neutron transport and slowing-down processes, and the basic nuclear reactor theory.	✓	✓	✓	✓	✓	
Tutorial	Homework, in class quiz review.	✓	✓	✓	✓	✓	
Self-study Activities	Pre-reading course materials, doing assignments.	✓	✓	✓	✓	✓	
Mini-project	Choose one of Generation-IV (Gen-IV) reactors or D-T fusion reactor, study, review, discussion and presentation.	✓	✓	✓	✓	✓	

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.					Weighting*	Remarks
	1	2	3	4	5		
Continuous Assessment: 50 %							
Homework	✓	✓	✓	✓	✓	20%	For every lecture, total 11
Mini-project	✓	✓	✓	✓	✓	10%	Report submission and presentation to be made
Quiz	✓	✓	✓	✓	✓	20%	Taken during every lecture, total 11 times
Examination: 50 % (duration: 2 hours)							
Examination	✓	✓	✓	✓	✓		
** The weightings should add up to 100%.*						100%	

For a student to pass the course, at least 30% of the maximum mark for both coursework and examination should be obtained.

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Homework	Capacity to practice the problems related to the key concepts, principles, and theories after the lectures.	High	Significant	Moderate	Not even reaching marginal levels
2. Mini-project	Ability to explain in detail for the design of advanced nuclear energy system.	High	Significant	Moderate	Not even reaching marginal levels
3. Quiz and class performance	Capacity to understand the basic concepts and the important theories and principles during the lectures.	High	Significant	Moderate	Not even reaching marginal levels
4. Examination	Capacity to understand the key concepts, principles, theories, and their applications in fundamentals of nuclear physics, nuclear reactors and nuclear power plants, neutron transport and slowing-down processes, and the basic nuclear reactor theory.	High	Significant	Moderate	Not even reaching marginal levels

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Homework	Capacity to practice the problems related to the key concepts, principles, and theories after the lectures.	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Mini-project	Ability to explain in detail for the design of advanced nuclear energy system.	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Quiz and class performance	Capacity to understand the basic concepts and the important theories and principles during the lectures.	High	Significant	Moderate	Basic	Not even reaching marginal levels
4. Examination	Capacity to understand the key concepts, principles, theories, and their applications in fundamentals of nuclear physics, nuclear reactors and nuclear power plants, neutron transport and slowing-down processes, and the basic nuclear reactor theory.	High	Significant	Moderate	Basic	Not even reaching marginal levels

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

(An indication of the key topics of the course.)

- Nuclear Fission/Nuclear Fusion
- Nuclear Reactions
- Distribution of Nuclides
- Neutron Reactions and Characteristics
- Scattering of Neutrons
- Nuclear Fission
- Chain Reaction
- Neutron Flux and Cross-section
- Criticality
- Neutron moderators
- Moderators and reactor design
- Delayed neutrons and controllability
- Effects of temperature and voiding on core reactivity
- Reactor poisons
- Transport Equation and Diffusion Equation
- Interaction of fast neutrons with matter

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	J.R. Lamarsh and A.J. Baratta, "Introduction to Nuclear Engineering", Prentice Hall, ISBN: 0-201-82498-1.

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	George Bell and Samuel Glasstone, "Nuclear Reactor Theory", Robert E. Krieger Publishing, ISBN: 0-882-75790-3.