MNE8114: FUNDAMENTALS OF NUCLEAR ENGINEERING

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Fundamentals of Nuclear Engineering

Subject Code
MNE - Mechanical Engineering
Course Number
8114

Academic Unit
Mechanical Engineering (MNE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
R8 - Research Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

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.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Learn the nuclear physics and interaction of radiation particles with matter.	20		x	
2	Describe the principles of fission nuclear reactors and different types of nuclear power plants.	10	x		
3	Identify how the complex neutron transport and slowing-down processes can be described by simple analytical models.	30		x	
4	Demonstrate the basic nuclear reactor theory, including one-group reactor equation, multi-group calculations and heterogeneous reactors.	30		x	
5	Study the conceptual design of Generation-IV (Gen-IV) reactors and D-T fusion reactors.	10	x		

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 real-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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	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.	1, 2, 3, 4, 5	
2	Tutorial	Homework, in class quiz review.	1, 2, 3, 4, 5	

3	Self-study Activities	Pre-reading course materials, doing assignments.	1, 2, 3, 4, 5	
4	Mini-project	Choose one of Generation-IV (Gen-IV) reactors or D-T fusion reactor study, review, discussion and presentation.	1, 2, 3, 4, 5	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Homework	1, 2, 3, 4, 5	20	For every lecture, total 11	Yes
2	Mini-project	1, 2, 3, 4, 5	10	Report submission and presentation to be made	Yes
3	Quiz	1, 2, 3, 4, 5	20	Taken during every lecture, total 11 times	No

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

30

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

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

Assessment Rubrics (AR)

Assessment Task

Homework (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Capacity to practice the problems related to the key concepts, principles, and theories after the lectures.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Mini-project (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Ability to explain in detail for the design of advanced nuclear energy system.

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Quiz and class performance (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Capacity to understand the basic concepts and the important theories and principles during the lectures.

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
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.

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Homework (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Capacity to practice the problems related to the key concepts, principles, and theories after the lectures.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Not even reaching marginal levels

Assessment Task
Mini-project (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Ability to explain in detail for the design of advanced nuclear energy system.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Not even reaching marginal levels

Assessment Task
Quiz and class performance (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Capacity to understand the basic concepts and the important theories and principles during the lectures.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Not even reaching marginal levels

Assessment Task
Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
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.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Not even reaching marginal levels

Part III Other Information

Keyword Syllabus
- 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

Reading List

Compulsory Readings

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

Additional Readings

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