MNE6138: FUNDAMENTALS OF NUCLEAR ENGINEERING

Effective Term
Semester A 2026/27

Part I Course Overview

Course Title
Fundamentals of Nuclear Engineering

Subject Code
MNE - Mechanical Engineering
Course Number
6138

Academic Unit
Mechanical Engineering (MNE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
MNE8114 Fundamentals of Nuclear Engineering

Exclusive Courses
Nil

Part II Course Details

Abstract

The course offers students a comprehensive foundation in the diverse field of nuclear engineering. Key topics include atomic and nuclear physics, neutron physics, the interaction of radiation with matter, nuclear materials, nuclear protection, nuclear shielding, the principles of fission reactors, nuclear reactor theory, risk assessment, and the development of advanced nuclear energy systems. Students will also learn to identify and apply essential concepts in neutron transport theory, diffusion theory, criticality calculations, reactor kinetics, and neutron slowing down theory. This course equips students with the knowledge and skills necessary for advanced research and professional practice in nuclear engineering.

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	3 hrs/week

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	
2	Mini-project	1, 2, 3, 4, 5	10	Report submission and presentation to be made	
3	Quiz	1, 2, 3, 4, 5	20	Taken during every lecture, total 11 times	

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

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

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

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

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

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

Additional Information for AR

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

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
- Nuclear protection
- Nuclear shielding

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.