

MNE4112: NUCLEAR MATERIALS

Effective Term

Semester B 2024/25

Part I Course Overview

Course Title

Nuclear Materials

Subject Code

MNE - Mechanical Engineering

Course Number

4112

Academic Unit

Mechanical Engineering (MNE)

College/School

College of Engineering (EG)

Course Duration

One Semester

Credit Units

3

Level

B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

Nil

Precursors

Basic materials course

Equivalent Courses

Nil

Exclusive Courses

Nil

Part II Course Details

Abstract

The aims of this course are to equip students:

- with knowledge of the properties and structures of nuclear materials and engineering alloys used in nuclear power reactor applications; and
- with ability to identify the common range of nuclear fuel elements, assemblies, and fuel rod failure mechanisms as well as the materials issues involving the core internals, reactor pressure vessel, and primary circuit-piping systems for light water reactors (LWRs) and extended the materials issues into the advanced nuclear reactor systems.

Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the basic structure and properties of nuclear materials used for nuclear reactor systems.		x		
2	Describe the technology of fuel elements and assemblies for light water reactor applications.		x		
3	Outline the problems and remedies of nuclear fuels and the fuel rod failure mechanisms.			x	
4	Identify the materials problems and remedies regarding the core internals, reactor pressure vessel and primary circuit-piping systems.			x	
5	Identify radiation effects on nuclear materials.			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 basic materials physics, structural materials for nuclear systems.	1, 2, 3, 4, 5	3 hrs/week
2	Self-study Activities	Pre-reading course materials, doing assignments.	1, 2, 3, 4, 5	1.5 hr/week
3	Mini-project	Choose a major component in nuclear power plant, study, review, discussion and presentation.	1, 2, 3, 4, 5	1 hr/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
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 the systems in nuclear power plant.

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 materials science, nuclear fuels and nuclear structural materials; the possible stressors, failure mechanisms of structural materials and the remedies of them.

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**

- 1) Introduction to Nuclear Reactors Systems and their Materials
 - Structure and properties of materials used in the nuclear reactor systems.
 - Nuclear fuel elements, fuel assemblies and their technology.
 - Reactor core internals, reactor pressure vessel, and primary water-piping systems.
- 2) The Problems and Remedies of Nuclear Materials in Light Water Reactor
 - Fuel rod failure mechanisms.
 - Corrosion and inter-granular stress corrosion cracking.
 - Radiation damage and microstructural evolution.
 - Radiation effects in metals.

Reading List**Compulsory Readings**

Title	
1	“Light-Water Reactor Materials” , Donald R. Olander and Arthur T. Motta, 2014.

Additional Readings

Title	
1	“Aging and Life Extension of Major Light Water Reactor Components” , Ed. V.N. Shah and P.E. MacDonald, Elsevier Science Publishers B.V., ISBN 0-444-89448-9, (TK9203.L45A35), 1993.