MNE4112: NUCLEAR MATERIALS

Effective Term
Semester A 2022/23

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
MBE4112 Nuclear Materials

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.

Teaching and Learning Activities (TLAs)

	TLAs	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.