MNE4108: NUCLEAR REACTOR ENGINEERING

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Nuclear Reactor Engineering

Subject Code
MNE - Mechanical Engineering
Course Number
4108

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
MNE3107 Principles of Nuclear Engineering

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course aims to introduce the principles of thermal-hydraulic analysis of nuclear power systems, with special emphasis towards the analysis of nuclear power reactors.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Explain the principles of thermal-hydraulic analysis of nuclear power systems and teleoperated robotic inspection systems.				
2	Develop the conservation equations of mass, motion and energy in a generalized form.			x	
3	Apply the appropriate equations to specific phenomena arising in the design of nuclear systems.			x	x
4	Discuss the reactor transient response.			x	
5	Describe dynamic characteristics of a reactor and the effect of Xenon.			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	Delivery of the course will be achieved through a series of formal lectures supported by practical case studies.	1, 2, 3, 4, 5	3hrs/week

2	Mini-project	A typical thermal hydraulic problem for nuclear application will be given to students to solve. The students are expected to work in teams to tackle the given problems. This learning activity will be mainly student-led but with some structural guidance from the teacher. At the end of the learning activity, a presentation session will be organised for all the students to present their solutions for the given problem.	1, 2, 3, 4, 5	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Mid-term Test	1, 2, 3, 4	20	
2	Mini-project	1, 2, 3, 4, 5	20	Report submission and presentation to be made

Continuous Assessment (%)

40

Examination (%)

60

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

Mid-term Test

Criterion

Understand and be able to conduct the thermal analysis of nuclear fuel.

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 apply the learned theories to conduct the research and self-learning for a nuclear reactor thermal-hydraulics related topic.

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
Understand the basic principles of thermal-hydraulic analysis of nuclear power systems. Obtain the deep insight on the fuel thermal analysis, single and two phase flow and heat transfer inside the nuclear reactors.

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

- Fluid dynamics and heat transfer
- Thermal and hydraulic analysis of nuclear reactors
- Fluid systems analysis, two-phase flow and boiling
- Energy conversion methods
- Heat generation in nuclear reactors
- Thermal hydraulic design of reactor cores and plant components
- Reactor Kinetics
- Dynamic Characteristics of a Reactor
- Effect of Xenon
- Non-Destructive Testing (NDT) techniques such as Ultrasonic testing, Eddy current inspection, Infrared thermography, Shearography, impact acoustics technique, etc
- Basic robotics for tele-operated inspection and maintenance

Reading List

Compulsory Readings

	Title
1	Todreas, N. E., and Kazimi, M. S. Nuclear Systems I: Thermal Hydraulic Fundamentals. Taylor & Francis Group, LLC, Second Edition, 2011.

Additional Readings

	Title
1	Rust, J. H., Nuclear Power Plant Engineering. Haralson Publishing Company, ISBN-10: 0934534004.
2	Lamarsh, J. R. and Baratta, A. J. Introduction to Nuclear Engineering. Prentice Hall, ISBN: 0-201-82498-1.
3	Versteeg, H. K., and Malalasekera W. An Introduction to Computational Fluid Dynamics. The Finite Volume Method. Pearson-Prentice Hall, ISBN: 978-0-13-127498-3.