MNE4131: NUCLEAR REACTOR DESIGN

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Nuclear Reactor Design

Subject Code
MNE - Mechanical Engineering
Course Number
4131

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
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract
As the only baseline energy source with zero carbon emissions, nuclear energy will play a key role in order to achieve the goal of carbon neutrality by the middle of the century. Proper and advanced designs of nuclear reactors are vital to

ensure safety and economic competitiveness of nuclear energy. This course involves integration of nuclear and reactor physics, thermal-hydraulics, safety, materials, and nuclear power plant components and systems. It provides opportunities to synthesize knowledge acquired in nuclear and non-nuclear subjects and apply this knowledge to practical problems of current interest in nuclear applications design.

The overall design project is the integration of several sub-projects. Accordingly, the class will be divided into several teams with one team focuses on a specific sub-project. The project requires design parameters selection, optimization, and engineering judgment as a team. The parameter selection and design of one team will impact the design of other teams. Therefore, individual work as well as teamwork will be required to successfully complete this project.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the key components and system designs for the selected nuclear reactor.		x	x	x
2	Explain the principles and functions of components and systems of nuclear reactor.		x	x	x
3	Analyse the reactor behaviour for the aspects of the nuclear and reactor physics, thermal-hydraulics, safety, and materials.		x	x	x
4	Demonstrate reflective practice in an engineering context.		x	x	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	Take place in classroom setting which consists of lectures on reactor design with different topics related to nuclear and reactor physics, thermal-hydraulics, safety, materials, and nuclear power plant components and systems.	1, 2, 3, 4	1 hr for 13 weeks

2	Group project	With the guidance of lecturers/TAs, students work both individually and as a team to perform the design and analysis for a specific sub-task. The discussions and presentations inside the team and to the whole class will be conducted to achieve the overall design goal.	1, 2, 3, 4	2 hrs for 13 weeks

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Progress reports/ presentations	1, 2, 3, 4	40	Presentations and reports
2	Final presentations and reports	1, 2, 3, 4	60	Presentations and reports

Continuous Assessment (%)

100

Examination (%)

0

Assessment Rubrics (AR)

Assessment Task

1. Progress reports/presentations

Criterion

Ability to understand the theory and engineering practices learned in the class and make good progress in the design project.

Excellent (A+, A, A-)

High
Strong evidence of critical thinking; good organization, capacity to analyse and synthesize, and team work; superior grasp of subject matter.

Good (B+, B, B-)

Significant
Significant evidence of critical capacity and analytic ability, and team work; good understanding of design assignments.

Fair (C+, C, C-)

Moderate
Student who is profiting from the design project; understanding of the project; good team work; ability to develop solutions to the issues related to the project.

Marginal (D)

Basic
Familiarity with the design matter; perform team work; some ability to find solutions related to the design issues.

Failure (F)

Not even reaching marginal levels
Little evidence of familiarity with the design project; weakness in critical and analytic skills; limited ability to make reasonable progress.

Assessment Task

2. Final presentations and reports

Criterion

Ability to apply the learned theories and knowledge to conduct the analysis and design project for a selected nuclear reactor.

Excellent (A+, A, A-)

High
Strong evidence of critical thinking; good organization, capacity to analyse and synthesize; superior grasp of subject matter; strong evidence of extensive knowledge of the design project.

Good (B+, B, B-)

Significant
Significant evidence of critical capacity and analytic ability; good understanding and knowledge of design projects.

Fair (C+, C, C-)

Moderate
Student who is profiting from the design project; reasonable understanding and knowledge of design projects.

Marginal (D)

Basic
Familiarity with the design matter to enable the student to progress without repeating the course.

Failure (F)

Not even reaching marginal levels
Little evidence of familiarity with the design project; weakness in critical and analytic skills; limited ability to finish the design project.

Part III Other Information

Keyword Syllabus

- The key components, systems and design parameters for a selected nuclear reactor
- Nuclear and reactor physics analysis and design,
- Thermal-hydraulics analysis and design,
- Safety analysis and design,
- Materials analysis and design

Reading List

Compulsory Readings

	Title
1	Lamarsh, J. R. and Baratta, A. J., “Introduction to Nuclear Engineering”, 3rd Edition, Prentice Hall, 2001.

Additional Readings

	Title
1	Murray, R. L., “Nuclear Energy”, 6th Edition. Butterworth-Heinemann, 2009.
2	Todreas, N. and Kazimi, M., “Nuclear Systems I: Thermal Hydraulic Fundamentals”, CRC Press, Taylor & Francis Group, Boca Raton, U.S.A., 2012, ISBN: 978-1-4398-0887-0.
3	Knief, R. A., “Nuclear Engineering: Theory and Technology of Commercial Nuclear Power”, 2nd Edition., American Nuclear Society, c2008.
4	Kok, Kenneth D., “Nuclear Engineering Handbook”, CRC Press, ISBN: 978-1-4200-5390-6.