MNE4105: NUCLEAR REACTOR SAFETY

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Nuclear Reactor Safety

Subject Code
MNE - Mechanical Engineering
Course Number
4105

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
MBE3107/MNE3107 Principles of Nuclear Engineering

Precursors
Nil

Equivalent Courses
MBE4105 Nuclear Reactor Safety

Exclusive Courses
Nil

Part II Course Details

Abstract
Nuclear reactor safety analysis often involves multiphysics from many disciplines simultaneously in achieving satisfactory solutions. The course aims to equip the students with the basic principles of nuclear reactor safety analysis, and with

the understanding of the complete nuclear reactor system including the balance of plant, support systems and resulting interdependencies affecting the overall safety of the plant and regulatory oversight.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the basic principles of nuclear reactor safety analysis.		x		
2	Explain the reactor safety systems and their functions.		x	x	
3	Model the reactor transients, accidents, and safety analysis.			x	x
4	Analyse the nuclear reactor safety.			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.

Teaching and Learning Activities (TLAs)

	TLAs	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	3 hrs/week
2	Mini-project	A typical reactor modelling and simulation task 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	

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	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 the safety analysis fundamentals, accidents scenarios, safety system functions.

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 power plant safety 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 nuclear reactor safety analysis, and with the understanding of the complete nuclear reactor system including the balance of plant, safety system, support systems and resulting interdependencies affecting the overall safety of the plant and regulatory oversight.

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
- Basic radioactivity;
- Basic dosimetry;
- Decontamination and radioactive waste disposal;
- Overview of nuclear reactors and reactor physics;
- Reactor kinetics and control;
- Nuclear fuel depletion and related effects;
- Nuclear plant power cycles, reactor design and energy transport;
- Reactor safety systems and their functions;
- Reactor transients, accidents, and safety analysis;

- Major nuclear accidents: Fukushima, Three Mile Island, and Chernobyl;
- Probabilistic risk analysis;
- Reactor operational requirements, safety culture and regulations;
- Nuclear reactor simulator in safety analysis;
- Advanced reactor designs to achieve better reactor safety.

Reading List

Compulsory Readings

	Title
1	Knief R. A., Nuclear Engineering: Theory and Technology of Commercial Nuclear Power, 2nd ed., American Nuclear Society, c2008.

Additional Readings

	Title
1	El-Wakil M. M., Nuclear Energy Conversion, Intext Educational Publishers, 1971, ISBN: 9780700223107.
2	Ott Karl O. and Neuhold Robert J., Introductory Nuclear Reactor Dynamics, American Nuclear Society, ISBN-10: 0894480294.
3	Akcasu Ziya, Shotkin Louis M., Akcasu Ziyaeddin A. and Lellouche Gerald S., Mathematical Methods in Nuclear Reactor Dynamics (Nuclear Science & Technology), Academic Press Inc., ISBN-10: 0120471507.
4	Lamarsh J. R. and Baratta A. J., Introduction to Nuclear Engineering, Prentice Hall, ISBN: 0-201-82498-1.
5	Jones O. C. Jr., Nuclear Reactor Safety Heat Transfer, Hemisphere, ISBN: 0- 891-116-224-0.
6	Collier J. G., Convective Boiling and Condensation, McGraw Hill, ISBN: 0-07-011798-5.
7	Plate E. J., Engineering Meteorology, Hemisphere, ISBN: 0 444 419792 1.