MNE5103: RISK AND RELIABILITY ENGINEERING

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Risk and Reliability Engineering

Subject Code
MNE - Mechanical Engineering
Course Number
5103

Academic Unit
Mechanical Engineering (MNE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course aims to present the mathematical modelling and system simulation methods for evaluating, managing and controlling the reliability, safety and risk of complex engineering systems such as the nuclear systems. The objective is to provide the students with the adequate tools for handling with scientific rigor the complexities and uncertainties associated to the problem. Previous knowledge on basic probability theory and statistics is helpful.

The expertise offered is part of the background knowledge of safety, reliability and risk analysts, operators and managers, in the industrial sector, including in particular nuclear. Practical examples and numerical exercises will be provided in support to the comprehension of the material covered in class.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Explain the key aspects of reliability and risk engineering.		x	x	
2	Apply effectively some of the methods of risk assessment (e.g. hazard identification, fault tree and event tree analyses, etc.).			x	x
3	Identify the risk-critical points of a system and optimally decide on their elimination or protection of the systems' environment.			x	x
4	Implement the risk assessment in the nuclear industry.			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	Lectures on the topics of the keyword syllabus.	1, 2, 3, 4	3 hrs/week
2	Individual work Activities (Self study)	Students are required to carry out self study on webs and search appropriate information/ data in conjunction with the lecturing materials to accomplish a set of given requirements. The work of the self study will be presented as an individual report for assessment.	1, 2, 3, 4	(20 hours)

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	2, 3, 4	30	

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

Mid-term Test (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Through the mid-term examination, the students will be evaluated on the base knowledge in the risks and reliabilities.

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 (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Through the mini-project, the students will be evaluated on the understanding and application of the learned knowledge to the risk modelling and assessment in engineering, societal and/or financial risk problems.

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 (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
Through the examination, the students will be evaluated on the application knowledge in the risks and reliabilities to engineering problems.

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
Mid-term Test (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Through the mid-term examination, the students will be evaluated on the base knowledge in the risks and reliabilities.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Not even reaching marginal levels

Assessment Task

Mini-project (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Through the mini-project, the students will be evaluated on the understanding and application of the learned knowledge to the risk modelling and assessment in engineering, societal and/or financial risk problems.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Moderate

Failure

(F) Not even reaching marginal levels

Assessment Task

Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Through the examination, the students will be evaluated on the application knowledge in the risks and reliabilities to engineering problems.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Moderate

Failure

(F) Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

- Definition of reliability, availability, safety, risk; structure of risk analysis
- Probabilistic Risk Assessment (PRA)
- Hazard identification: functional analysis, Hazard Operability (HAZOP) analysis and Failure Modes, Effects and Criticality Analysis (FMECA)
- Reliability and availability of simple systems
- Fault tree and event tree analysis
- Markov models for reliability and availability analysis
- Monte Carlo simulation for reliability and risk analysis
- Common cause failures
- Important measures

- Industrial examples

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	Zio E., An introduction to the basics of reliability and risk analysis, World Scientific, 2007.
2	Zio E., Computational methods of reliability and risk analysis, World Scientific, 2009.
3	Zio, E. Baraldi P. and Cadini F., Basics of reliability and risk analysis: Worked Out Problems and Solutions, World Scientific, 2011.
4	Kroger, W. and E. Zio, Vulnerable systems, Springer, 2011.