MNE4109: RELIABILITY ENGINEERING AND RISK ANALYSIS

Effective Term
Semester A 2024/25

Part I Course Overview

Course Title
Reliability Engineering and Risk Analysis

Subject Code
MNE - Mechanical Engineering
Course Number
4109

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
MA1200 Calculus and Basic Linear Algebra I OR
MA1300 Enhanced Calculus and Linear Algebra I

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course entails the acquisition of concepts, fundamentals and methods of reliability estimation and risk analysis for components, products and complex systems. Aimed at providing an organic view of the subject, this course provides the students with an introduction to the principal concepts and issues related to reliability, availability and maintainability modeling and estimation; in addition, it focuses on the conceptual aspects of risk analysis and presents commonly known risk analysis methodologies.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe basic notions of probability and statistics concepts within the context of their use in reliability and risk analyses.		x		
2	Construct reliability/availability parameter estimation, and reliability and maintainability models for failure data.			x	x
3	Analyze and understand the phenomenology of failures, causes and mechanisms of failures of components and mechanical, aerospace, chemical, nuclear systems.			x	x
4	Apply commonly used techniques to reliability and risk analyses of components, products and complex systems operating in different conditions.			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	Students will engage in formal lectures that are related to reliability, availability, and maintainability. Students will also engage in lectures that introduce common risk analysis tools and methodologies used to deal with engineering, societal and financial risk problems, taking nuclear, aerospace, mechanical systems as cares of study.	1, 2, 3, 4	3 hrs/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Test(s) and Quiz(zes)	1, 2, 3, 4	30	
2	Homework	1, 2, 4	20	

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

1. Test(s) and Quiz(zes)

Criterion

Ability to show understanding on methodologies and tools for risk analysis of nuclear engineering systems, including calculations of Bayesian probability, event tree, and fault tree.

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
2. Homework

Criterion
Ability to complete challenging assignments on developing event tree, fault tree and consequence analyses.

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
3. Examination

Criterion
Ability to derive the relevant equations, and explain important terminologies and concept in probabilistic risk assessment.

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 notions of probability theory
- Reliability and hazard functions
- Reliability of simple systems
- Availability
- Design for maintainability
- Markov availability and reliability
- Reliability parameter estimation
- Physics of failures
- Accelerated life testing
- Quantitative risk analysis
- System resilience

Reading List

Compulsory Readings

	Title
1	Elsayed A. Elsayed, Reliability Engineering, Third Edition (Wiley Series in Systems Engineering and Management), 2021, ISBN 1119665922.
2	Enrico Zio, An Introduction to the Basics of Reliability and Risk Analysis, World Scientific Publishing Co., ISBN 978-981-270-639-3.

Additional Readings

	Title
1	E. Balagurusamy, Reliability Engineering, Tata McGraw-Hill Education, 1984, ISBN 0070483396.
2	Enrico Zio, Piero Baraldi, and Francesco Cadini, Basics of Reliability and Risk Analysis: Worked Out Problems and Solutions, World Scientific Publishing Co., ISBN 978-981-4355-03-2.
3	Tim Bedford and Roger Cooke, Probabilistic Risk Analysis: Foundations and Methods, Cambridge University Press, ISBN 9780521773201.
4	Mark G. Stewart and Robert E. Melchers, Probabilistic Risk Assessment of Engineering Systems, Chapman & Hall, ISBN 0412805707.