

# MNE4109: RELIABILITY ENGINEERING AND RISK ANALYSIS

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## Effective Term

Semester A 2025/26

## 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 DEC-A1 DEC-A2 DEC-A3 app.)			
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 ("- for nil entry)	Allow Use of GenAI?	
1	Test(s) and Quiz(zes)	1, 2, 3, 4	30	-	No
2	Homework	1, 2, 4	20	-	Yes

**Continuous Assessment (%)**

50

**Examination (%)**

50

**Examination Duration (Hours)**

2

**Minimum Continuous Assessment Passing Requirement (%)**

30

**Minimum Examination Passing Requirement (%)**

30

**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

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**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

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**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

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**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.