MNE4109: RELIABILITY ENGINEERING AND RISK ANALYSIS

Effective Term
Semester A 2022/23

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
Nil

Precursors
Nil

Equivalent Courses
MBE4109 Risk Engineering for Applications Related to Nuclear Engineering

Exclusive Courses
Nil

Part II Course Details

Abstract

This course entails the acquisition of appropriate techniques for reliability, safety and risk analysis for industrial 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 the reliability analysis and risk assessment of modern industrial activities.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe basic notions of probability concepts related to reliability, safety and risk analyses, and frame work of Probabilistic Reliability and Safety Analysis of complex systems.		x		
2	Construct reliability/availability parameter estimation, fault tree analysis, event tree analysis, importance measures, sensitivity analysis and sequence quantification.			x	x
3	Analyze the phenomenology of failure, repair, ageing, maintenance of components, within the reliability, safety and risk analysis and dependability analysis of mechanical, aerospace, chemical, nuclear systems.			x	x
4	Conduct computational techniques for reliability, safety and risk analysis of complex systems operating in stationary or dynamic 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.

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. A series of lectures will introduce the common risk analysis tools and methodologies used in the nuclear industry.	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	30	

Continuous Assessment (%)

60

Examination (%)

40

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

- Introduction to Reliability, Safety and Risk Analysis
- Basic notions of probability theory
- Reliability of simple systems
- Availability
- Markov availability and reliability
- Introduction to Monte Carlo Simulation
- Reliability Parameter Estimation
- Probabilistic Risk Analysis
- Fault Tree Analysis
- Event Tree Analysis
- Dependent failure
- Importance measures
- Uncertainty and sensitivity analysis

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	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.
2	Enrico Zio, Computational Methods for Reliability and Risk Analysis, World Scientific Publishing Co., ISBN 978-981-283-901-5.
3	Enrico Zio, An Introduction to the Basics of Reliability and Risk Analysis, World Scientific Publishing Co., ISBN 978-981-270-639-3.
4	Tim Bedford and Roger Cooke, Probabilistic Risk Analysis: Foundations and Methods, Cambridge University Press, ISBN 9780521773201.
5	Mark G. Stewart and Robert E. Melchers, Probabilistic Risk Assessment of Engineering Systems, Chapman & Hall, ISBN 0412805707.
6	Terje Aven, Piero Baraldi, Roger Flage and Enrico Zio, Uncertainty in Risk Assessment, John Wiley & Sons, Ltd, ISBN 9781118489581.
7	E. Balagurusamy, Reliability Engineering, Tata McGraw-Hill Education, 1984, ISBN 0070483396.