ADSE4064: RELIABILITY ENGINEERING

Effective Term
Semester A 2023/24

Part I Course Overview

Course Title
Reliability Engineering

Subject Code
ADSE - Advanced Design and System Engineering
Course Number
4064

Academic Unit
Systems Engineering (SYE)

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
SEEM3102 Quality Engineering / ADSE3102 Quality Engineering / SDSC3102 Quality Technologies

Precursors
Nil

Equivalent Courses
SEEM4064 Reliability Engineering

Exclusive Courses
Nil

Part II Course Details

Abstract

The aim of the course is to provide students with knowledge in concepts, methodology, and tools of reliability engineering. On completion of the course, the students should be able to construct models for the estimation and improvement of reliability parameters of manufactured products and components.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Define the concepts of reliability, common reliability functions, parameters and methods of their modeling and prediction.	10	x		
2	Identify importance of statistical distributions for modeling failure data, and the physical meanings of model parameters.	20	x		
3	Estimate reliability functions and parameters of an item using life testing, Weibull and hazard plotting, stress-stress analysis, and relevant reliability databases.	20		x	
4	Determine system reliability using reliability block diagram, fault tree and event tree.	20		x	
5	Evaluate maintainability and availability of product/component systems, and different maintenance strategies.	20			x
6	Describe the benefits and elements of reliability program and product liability management.	10			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	Classroom Activities	Learning through teaching is primarily based on lectures. Mini-lectures and small-group exercises will be used to facilitate conceptual understanding and industrial applications of various reliability modeling and prediction methods.	1, 2, 3, 4, 5, 6	39 hours/ semester
2	Tutorial Exercises	The team-based exercises provide students with the opportunities to i/ familiarize and apply the statistical tools learnt during the lectures through practical problem solving, and ii/ appreciate the use of commercial reliability analysis software Relex in modeling and prediction of item and system reliability.	3, 4, 5	10 hours/ semester
3	Laboratory Work	The team-based exercise enables students to design, conduct and analyze reliability experiments using software such as Relex.	2	6 hours/ semester

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Quiz(es)	1, 2, 3, 4	10	
2	Tutorial Exercises	2, 3, 4, 5	20	
3	Laboratory Report	3	10	

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 the examination should be obtained.

Assessment Rubrics (AR)

Assessment Task
Quiz(s)

Criterion
30 – 40 minutes short quiz(s) to assess students' understanding of the reliability concepts and the modeling and prediction techniques introduced in the lectures.

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
Tutorial Exercises

Criterion
Students' ability to analyze reliability data, apply relevant statistical tools with the help of software, and draw informed conclusions in solving practical reliability problems are assessed. Explanation and presentation of results are also assessed.

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
Laboratory Report

Criterion
The laboratory report assesses students' ability to design, conduct and analyze reliability experiments. Interpretations of the numerical results and their practical implications are particularly sought for.

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
Examination questions are designed to assess student' s level of achievement of the intended learning outcomes, with balanced emphasis placed on both conceptual understanding and practical applications of the various reliability modeling and prediction methods introduced.

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
The quiz(s), tutorial exercises and laboratory report will be numerically-marked, while examination will be numerically-marked and grades-awarded accordingly.

Part III Other Information

Keyword Syllabus

- **Concepts and Mathematical Models for Reliability**
  Concept of reliability, quality and safety, probability and distributions for reliability
- **Reliability and Life Cycle**
  Reliability parameters: MTTF and failure rate; failure model and pattern – Normal/Exponential/Weibull distribution; bathtub curve and life cycle;
- **Reliability Testing and Estimation**

Burn-in testing, accelerated life testing, point and interval estimation of parameters from observed data, analysis of censored data, stress-strength analysis

- **Databases of failure rates of electronics/mechanical components**

  MIL-HDBK-217, Bellcore (Telcordia) reliability prediction procedure for electronic equipment, reliability estimation using general failure rate data

- **System Reliability and Redundancy**

  Reliability block diagram, parallel and series configuration, active and standby redundancy, redundancy allocation

- **System Safety Analysis**

  Fault tree, event tree, FMEA, Qualitative/quantitative approaches, minimum cut-set

- **Maintainability and Availability**

  Maintenance time distribution, maintenance strategy, maintainability prediction and design, repairable systems, reliability growth,

- **Reliability Management**

  Reliability function and management in organization, reliability of internet-of-things and cyber-physical systems, product safety and liability

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	E.A. Elsayed, Reliability Engineering. Wiley, 2021.
2	Charles, E. Ebeling, An Introduction to Reliability and Maintainability Engineering, McGraw-HILL, 2019
3	A Birolini, Reliability Engineering Theory and Practice, Springer, 2017.