Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Digital Factory and Industrial Maintenance
Course code	47560
Scientific sector	ING-IND/17
Degree	Master in Industrial Mechanical Engineering
Semester	2nd
Year	I
Academic year	2025/26
Credits	5
Modular	Yes

Total lecturing hours	30 hrs
Total lab hours	18 hrs
Total exercise hours	-
Attendance	Recommended
Prerequisites	none
Course page	https://www.unibz.it/en/faculties/engineering/master-industrial-mechanical-engineering/course-offering/?academicYear=2025

Specific educational objectives	The course offers both basic and advanced knowledge on the maintenance and reliability of complex industrial systems, with a particular focus on production systems. The topics will be covered through a mix of theoretical classes, numerical exercises, and case study discussions. Key areas include the design and management of maintenance for industrial systems, modeling complex systems reliability, functional safety of machinery, methodologies for reliability design and evaluation

Lecturer	Dr. Luca Gualtieri, luca.gualtieri@unibz.it
Scientific sector of the lecturer	ING-IND/17
Teaching language	English
Office hours	By appointment
Teaching assistant *(if any)*	tbd
Office hours	-
List of topics covered	The course covers the following topics: Lecture 1. Introduction to maintenance of industrial systems: basic concepts and definitions, maintenance objectives, failure classification, failure causes, maintenance strategies, maintenance management;

	2. Modeling systems reliability: reliability of systems, reliability functions, systems availability, mean time to failure and mean time to repair, failure rate profiles, useful life and service life, systems with constant failure rate; 3. Reliability of complex systems: reliability block diagrams, serial configurations, parallel configurations, system redundancy, k-out-of-n configurations, non-identical k-out-of-n configurations of independent components, basic concepts of predictive maintenance and condition monitoring; 4. Functional safety of machinery: safety and reliability in machinery control systems, functional safety of machinery, Safety Related Parts of Control Systems, ISO 13849-1 methodology for PL and PLr calculation, performance levels. 5. Methodologies for reliability design and evaluation: Failure Modes and Effects Analysis, Failure Mode Effects and Criticality Analysis, Fault Tree Analysis. Laboratory: 6. Calculation of reliability parameters of non-reparable systems; 7. Calculation and comparison of reliability functions for serial and parallel systems; 8. Design of SRP/CSs according to ISO 13849-1 methodology; 9. Development of quantitative Failure Mode Effects and Criticality Analysis; 10. Development of Fault Tree Analysis; 11. Exercise on failure prediction; 12. Use cases discussion.
Teaching format	Frontal lectures supplemented by (numerical) exercises and case studies.

Learning outcomes	Knowledge and understanding The students will be able to master basic and advanced concepts of industrial maintenance and reliability theory. They will gain an understanding of the concepts related to the modeling of reliability for both simple and complex systems, the application of reliability theory to the functional safety of machinery, methodologies for reliability design and evaluation, and strategies for maintenance management. Applying knowledge and understanding The students will be able to analyze and discuss the reliability of complex industrial systems. Furthermore, they will apply the acquired theoretical concepts using

	tools and methodologies for designing and assessing reliable and safe production systems. Making judgments According to specific conditions, students will be able to critically evaluate the appropriateness of various approaches and tools related to advanced maintenance principles, reliability of complex systems, methodologies for reliability design and evaluation, functional safety applied to industrial machinery, and predictive maintenance. Communication skills Students will be able to use technical vocabulary related to the covered topics. Furthermore, they will be able to structure, prepare, and present scientific and technical documentation describing project activities and discuss them with decision-makers. Learning skills Students will be able to autonomously expand their knowledge acquired during the course through reading and understanding scientific and technical documentation (including that provided by lecturers). Similarly, they will be able to expand their skills in using methodologies and tools for reliable systems design and maintenance management, investigating the use of cross-cutting or specific approaches to solve problems similar to those covered in the course.

Assessment

Evaluation will be by written examination supplemented by a report developed and discussed by the student.

The written part will consist of answering theoretical questions and/or completing exercises on the topics covered in the course.

The report will be related to a group/individual work assigned by the lecturer to deepen a specific topic or methodology. discussed during the course.

The parts of the final exam are following summarized:

Form	Duration	Contribution to final grade
Written part (answering theoretical questions and/or completing exercises)	2 hours	80%

	Groupwork/individual report and discussion	To be carried out in the classroom and/or independently	20%
Assessment language	English		
Evaluation criteria and criteria for awarding marks	Criteria for evaluation of the written examination: correctness and completeness of answers. Criteria for evaluation of the group/individual work: correctness and completeness of the results and analyses provided in the report, as well as quality of the discussion and completeness of the answers to potential specific questions.		

Required readings	References to textbooks, lecture notes, research papers, and readings may be provided by the lecturers.
Supplementary readings	1. Rausand, M. (2014). Reliability of safety-critical systems: theory and applications. John Wiley & Sons. 2. Manzini, R., Regattieri, A., Pham, H., & Ferrari, E. (2010). Maintenance for industrial systems (pp. 409-432). London: Springer