Syllabus

Course Description

Course Title	Digital Factory and Industrial Maintenance
Course Code	47560
Course Title Additional	
Scientific-Disciplinary Sector	IIND-05/A
Language	English
Degree Course	Master in Industrial Mechanical Engineering
Other Degree Courses (Loaned)	
Lecturers	Prof. Luca Gualtieri, Luca.Gualtieri@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/38728
Teaching Assistant	
Semester	Second semester
Course Year/s	1
CP	5
Teaching Hours	30
Lab Hours	18
Individual Study Hours	77
Planned Office Hours	
Contents Summary	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.
Course Topics	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.
Keywords	Reliability engineering; Industrial maintenance; Functional Safety of machinery; Methodologies for reliability design and evaluation:
Recommended Prerequisites	None.
Propaedeutic Courses	
Teaching Format	Frontal lectures supplemented by (numerical) exercises and case

	studies.
Mandatory Attendance	Recommended.
Specific Educational Objectives and 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.
Specific Educational Objectives and Learning Outcomes (additional info.)	
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: Written part (answering theoretical questions and/or completing exercises): 2 hours; Contribution to final grade: 80%; Groupwork/individual report and discussion: Groupwork/individual report and discussion To be carried out in the classroom and/or independently; Contribution to final grade: 20%.
Evaluation Criteria	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.
Further Information	
Sustainable Development Goals (SDGs)	Industry, innovation and infrastructure, Decent work and economic growth