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	2023/24
Credits	5
Modular	Yes

Total lecturing hours	32 hrs
Total lab hours	12 hrs
Total exercise hours	-
Attendance	Recommended
Prerequisites	none
Course page	https://www.unibz.it/en/faculties/engineering/master-industrial-mechanical-engineering/course-offering/

Specific educational objectives	The first part of the course (Advanced Industrial Maintenance) aims to provide students with traditional and advanced concepts in maintenance design and management for manufacturing systems and related machinery, as well as methodologies for reliability risk management. The second part of the course (Digital Factory and Predictive Maintenance) aims at providing the students with concepts in digital condition monitoring, as well as models for the application of software-supported predictive maintenance.

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)*	-
Office hours	-
List of topics covered	The course covers the following topics: **Advanced Industrial Maintenance** Lecture 1. Advanced topics in production system maintenance (main concepts and definitions, objectives, failure classification, failure causes,

	corrective and preventive maintenance policies, maintenance management); 2. Modeling system reliability and availability (reliability of non-repairable systems, main functions for system's reliability and failure modeling, system's availability, failure rate profiles); 3. Reliability of complex systems (reliability block diagrams, redundant systems, parallel and serial configurations); 4. Methodologies for reliability risk management (Failure Modes and Effects Analysis, Fault Tree Analysis, human factors analysis); 5. Functional safety and maintenance of industrial machinery (introduction to functional safety, safety functions and safety-critical systems, risk assessment and performance levels, SRP/CS categories); Laboratory: 6. Use cases discussion and numerical exercises. **Digital Factory and Predictive Maintenance** Lecture 1. Models for condition monitoring supported by machine learning; 2. Predictive Maintenance: Data analysis procedure and definition of the model; 3. Predictive Maintenance: Data analysis process (data preparation, model creation, model validation, model application, assessment of results) 4. Predictive Maintenance with RStudio: Basic commands, use case analysis and dataset; Laboratory 5. Guided exercise on predictive maintenance application with RStudio software.
Teaching format	Frontal lectures supplemented by numerical exercises and case studies, exercises supported by dedicated software.

Learning outcomes	Knowledge and understanding In the first part, the students will be able to master advanced concepts of industrial maintenance and reliability theory. They will acquire concepts related to maintenance design and management, as well as about reliability risk management and design of reliable and safe manufacturing systems. In the second part, students will be able to master the fundamentals of condition monitoring to support data-driven maintenance. Furthermore, they will acquire the basic concepts related to the use of a software for the modeling and digital simulation of predictive maintenance

	process. Applying knowledge and understanding The students will be able to analyze and discuss reliability of complex industrial systems. Furthermore they will apply the acquired theoretical concepts by means of tools and methodologies for reliability risk management, and design and assessment of reliable and safe manufacturing systems. Furthermore, they will implement a model for condition monitoring in order to apply concepts of predictive maintenance by using a supporting software. 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, reliability risk management, functional safety applied to industrial machinery, data-driven condition monitoring 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 to 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 related to the use of the proposed (and similar) software, i.e. by using dedicated tutorials.
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 work assigned by the lecturer to deepen a specific topic or methodology discussed during the course.

<table>
<tr><td></td><td>The parts of the final exam are following summarized:
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<tr><th>Form</th><th>Duration</th><th>Contribution to final grade</th></tr>
<tr><td>Written part (answering theoretical questions and/or completing exercises)</td><td>2 hours</td><td>60%</td></tr>
<tr><td>Groupwork report and discussion</td><td>To be carried out in the classroom and/or independently</td><td>40%</td></tr>
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<tr><td>Assessment language</td><td>English</td></tr>
<tr><td>Evaluation criteria and criteria for awarding marks</td><td>Criteria for the evaluation of the written examination: correctness and completeness of answers.

Criteria for the evaluation of the groupwork: 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 specific questions.</td></tr>
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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