Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus

Kursbeschreibung

Titel der Lehrveranstaltung	Industrial Automation and Digital Manufacturing
Code der Lehrveranstaltung	47591
Zusätzlicher Titel der Lehrveranstaltung	
Wissenschaftlich-disziplinärer Bereich	
Sprache	Englisch
Studiengang	Master in Industrie- und Maschineningenieurwesen
Andere Studiengänge (gem. Lehrveranstaltung)	
Dozenten/Dozentinnen	dr. Matteo De Marchi, Matteo.DeMarchi@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/44826 Prof. Andrea Giusti, Andrea.Giusti@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/47728
Wissensch. Mitarbeiter/Mitarbeiterin	
Semester	Zweites Semester
Studienjahr/e	1
KP	10
Vorlesungsstunden	48
Laboratoriumsstunden	48
Stunden für individuelles Studium	0
Vorgesehene Sprechzeiten	
Inhaltsangabe	The course belongs to the class of characterizing courses in the Master in Industrial Mechanical Engineering. It aims at teaching both scientific foundations and practical

	methods and helps to develop specific professional skills in the domains of industrial robotics and digital manufacturing. Students will learn, in Module 1 "Industrial Robotics", fundamental concepts and methodologies for understanding and modelling industrial robots and their core components, i.e. essential knowledge and skills for developing models as well as for kinematics and dynamics evaluation and control; then, they will acquire fundamental knowledge and competences on how to simulate and program industrial robots by means of exercises and practical activities. Module 2 "Digital Manufacturing and Simulation" provides the basics in cyber-physical production systems, data- driven production, industrial internet of things, digital twin technology and simulation methodologies. Theoretical foundations will focus on the design, planning and implementation of connected machines and resources in production as well as the fundamentals of simulation for production and logistics. In addition to theoretical models and methods the practical use of cyber-physical systems as well as specific simulation software in the production environment is treated by means of exercises and practical case studies. Smart Mini Factory lab will serve as laboratory for both the modules.
Themen der Lehrveranstaltung	The course is composed of two modules whose topics are summarized as follows. Module 1 "Industrial Robotics": • introduction to robotics; • direct kinematics; • kinematic calibration; • inverse kinematics; • differential kinematics and statics; • trajectory planning; • basic components of robots; • robot dynamics and control (hints); • examples of programming of industrial robotic systems. Module 2 "Digital Manufacturing and Simulation": Part 1) SIMULATION • Fundamentals of simulation modelling

	• Principles, methods and procedures for implementing simulation studies • Fields of application for simulation • Software tools for simulation Part 2) DIGITAL MANUFACTURING • Introduction to data-driven production • Industrial Internet of Things • Data Analytics and retrofitting of legacy systems • Work 4.0 and digital worker assistance systems • Digital twins in manufacturing • Manufacturing cybersecurity Simulation Lab: 1. Introduction to FlexSim 2. Data analysis and distributions 3. Case study modelling (production plant and/or logistics systems modelling and simulation) 4. Advanced features and Virtual Reality practice Industrial Internet of Things (IoT) Lab: 1. Introduction to the case study 2. Retrofitting of legacy equipment 3. Hardware set-up and software coding 4. Data extraction and analysis 5. KPI visualization on IoT-platform.
Stichwörter	Industrial Robotics, Robotics Foundations, Cyber-physical Production Systems, Simulation, Planning
Empfohlene Voraussetzungen	None.
Propädeutische Lehrveranstaltungen	
Unterrichtsform	Frontal lectures. Practical parts and lab activities/exercises are planned also in the Smart Mini Factory laboratory.
Anwesenheitspflicht	Recommended (especially for exercise hours).
Spezifische Bildungsziele und erwartete Lernergebnisse	Knowledge and understanding: Module 1: The students will know the most important concepts of modelling, planning and control of industrial robotic systems and gain essential knowledge of robot components.

	Module 2: The student knows the basics and advanced features of simulation modelling and analysis as well as the current methods and tools for digitalization in manufacturing. Applying knowledge and understanding: The student applies and practices theoretical contents through exercises, case studies and project work. Theory contents are practiced through exercises using practical examples. From Module 1, the students will know how to treat a robotic system form a kinematic (position and speed) and static point of view as well as how to set-up a robotic simulator and motion control program. In Module 2 the students develop independently a simulation model for given case studies out from the production and logistics environment. In a second lab they practice IIoT and handling data with IoT platforms. Presentation techniques are trained using equipment such as flipcharts and power point presentations. Making judgements: Module 1: The student will be able to make judgments selecting a suitable robotic system for a practical industrial solution. Module 2: The student judges the use of appropriate methods, models and systems for simulation and Industrial IoT. Students can judge and interpret simulation results and data extracted from production and to use them for derivate measures for optimization. Communication skills: • Ability to present the acquired knowledge and competences with a proper language • Ability to express concepts with the field related technical terminology Learning skills: The students learn both by frontal teaching (theory part) as well as by exercises in the classroom and in the Smart Mini Factory lab (practical exercises). The students will be able to enlarge their knowledge through self-study and consultation of scientific and technical documentation.
Spezifisches Bildungsziel	

und erwartete Lernergebnisse (zusätzliche Informationen)	
Art der Prüfung	Assessment Module 1: Knowledge and understanding: written exam/reports Applying knowledge and understanding: individual/group work on assignment(s) Making judgements: individual/group work on assignment(s); Communication skills: group work on assignment(s), written/oral exam or presentation; Learning skills: individual/group work on assignment(s), written/oral exam or presentation. Assessment Module 2: Knowledge and understanding: written exam Applying knowledge and understanding: assignments in lab exercises Making judgements: assignments in lab exercises Communication skills: presentation of results of lab exercises Learning skills: lab exercises, written/oral exam Written exam means exam with review questions and exercises. Assignments in lab exercises means case study work and subsequent presentation of the results.
Bewertungskriterien	Final single grade by arithmetic average of the grades obtained in Module 1 and Module 2, provided that sufficient grade is achieved in both modules. Module 1: The grade for this module is calculated as the arithmetic average of the written exam (50%) and the assignment (50%). Module 2: The grade for the module is calculated 50% from the results of the written exam and 50% from the results of the project work performed in the Simulation lab and IIoT lab. Criteria for the evaluation of the written examination: - completeness and correctness of the answers.

	Criteria for the evaluation of the assignment / project work / case study: - accuracy and completeness, as well as creativity in structuring of the proposed solution; - quality of the results and quality of presentation.
Pflichtliteratur	Lecture notes and documents for exercises will be available on the course platform (e.g. Teams, OLE or reserve collections).
Weiterführende Literatur	**Module 1:** Siciliano, B., Villani, L., Oriolo, G., De Luca, A., Foundations of Robotics, Springer Cham, 2025. Siciliano, B., Sciavicco, L., Villani, L., Oriolo, G., Robotics: Modelling, Planning and Control. 1st ed. 2009. London: Springer London, 2009. Craig, John J., Introduction to Robotics Mechanics and Control. Fourth edition. New York: Pearson, 2018. **Module 2:** Applied simulation: modeling and analysis using FlexSim M. Beaversotck, A. Greenwood, W. Nordgren 2017 ISBN : 978-0-9832319-7-4 Available in the unibz library for students of this course Bozen-Bolzano University Library 14-Reference Collection ST 341 F34 B386 Industrial Internet of Things: Cybermanufacturing Systems edited by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat. Serie: Springer Series in Wireless Technology, Available online via unibz library database Springer Link
Weitere Informationen	
Ziele für nachhaltige	Industrie, Innovation und Infrastruktur, Menschenwürdige Arbeit

Entwicklung (SDGs)	und Wirtschaftswachstum

Kursmodul

Titel des Bestandteils der Lehrveranstaltung	Industrial Robotics
Code der Lehrveranstaltung	47591A
Wissenschaftlich-disziplinärer Bereich	IIND-02/A
Sprache	Englisch
Dozenten/Dozentinnen	Prof. Andrea Giusti, Andrea.Giusti@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/47728
Wissensch. Mitarbeiter/Mitarbeiterin	
Semester	Zweites Semester
KP	5
Verantwortliche/r Dozent/in	
Vorlesungsstunden	24
Laboratoriumsstunden	24
Stunden für individuelles Studium	79
Vorgesehene Sprechzeiten	
Inhaltsangabe	
Themen der Lehrveranstaltung	Foundations of industrial robotics including modelling, trajectory planning, and control of industrial robotic systems: • introduction to robotics; • direct kinematics; • kinematic calibration; • inverse kinematics; • differential kinematics and statics; • trajectory planning; • basic components of robots; • robot dynamics and control (hints); • examples of programming of industrial robotic systems.
Unterrichtsform	Frontal lectures.

	Practical parts and lab activities/exercises are planned also in the Smart Mini Factory laboratory.
Pflichtliteratur	Lecture notes and documents for exercises will be available on the course platform (e.g. Teams, OLE or reserve collections).
Weiterführende Literatur	**Module 1:** Siciliano, B., Villani, L., Oriolo, G., De Luca, A., Foundations of Robotics, Springer Cham, 2025. Siciliano, B., Sciavicco, L., Villani, L., Oriolo, G., Robotics: Modelling, Planning and Control. 1st ed. 2009. London: Springer London, 2009. Craig, John J., Introduction to Robotics Mechanics and Control. Fourth edition. New York: Pearson, 2018.

Kursmodul

Titel des Bestandteils der Lehrveranstaltung	Digital Manufacturing and Simulation
Code der Lehrveranstaltung	47591B
Wissenschaftlich-disziplinärer Bereich	IIND-04/A
Sprache	Englisch
Dozenten/Dozentinnen	dr. Matteo De Marchi, Matteo.DeMarchi@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/44826
Wissensch. Mitarbeiter/Mitarbeiterin	
Semester	Zweites Semester
KP	5
Verantwortliche/r Dozent/in	
Vorlesungsstunden	24
Laboratoriumsstunden	24
Stunden für individuelles Studium	79
Vorgesehene Sprechzeiten	

Inhaltsangabe	
Themen der Lehrveranstaltung	Lecture: Part 1) SIMULATION • Fundamentals of simulation modelling • Principles, methods and procedures for implementing simulation studies • Fields of application for simulation • Software tools for simulation Part 2) DIGITAL MANUFACTURING • Introduction to data-driven production • Industrial Internet of Things • Data Analytics and retrofitting of legacy systems • Work 4.0 and digital worker assistance systems • Digital twins in manufacturing • Manufacturing cybersecurity Simulation Lab: 1. Introduction to FlexSim 2. Data analysis and distributions 3. Case study modelling (production plant and/or logistics systems modelling and simulation) 4. Advanced features and Virtual Reality practice Industrial Internet of Things (IoT) Lab: 1. Introduction to the case study 2. Retrofitting of legacy equipment 3. Hardware set-up and software coding 4. Data extraction and analysis 5. KPI visualization on IoT-platform.
Unterrichtsform	Frontal lectures and exercises in Smart Mini Factory Lab.
Pflichtliteratur	Lecture notes and documents for exercise will be available on the course platform (e.g. Teams, OLE or reserve collections).
Weiterführende Literatur	**Module 2** Applied simulation: modeling and analysis using FlexSim M. Beaversotck, A. Greenwood, W. Nordgren 2017 ISBN : 978-0-9832319-7-4 Available in the unibz library for students of this course

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