Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

COURSE DESCRIPTION – ACADEMIC YEAR 2024/2025

Course title	Modern Control
Course code	42412
Scientific sector	IINF-04/A
Degree	Bachelor in Electronics and Cyber-Physical Systems Engineering
Semester	II
Year	3
Academic Year	2024/25
Credits	9
Modular	no

Total lecturing hours	36
Total lab hours	54
Attendance	Attendance at lectures is strongly recommended. Attendance at exercise sessions is required.
Prerequisites	Lectures and exercises of Mathematical Analysis I and II; Linear Algebra; Physics I; Physics II; and Fundamentals of Systems and Control
Course page	

Specific educational objectives	The student should understand the basic principles of methods of modern control with focus on state-space control and optimal control and be able to apply them in exercises, including in Matlab and Simulink, as well as in laboratory experiments on real hardware.

Lecturer	Prof. Karl von Ellenrieder - Facoltà di Ingegneria Tel. : +39 0471 017172 E-mail: karl.vonellenrieder@unibz.it Web: https://www.unibz.it/faculties/person/37038-karl-dietrich-von-ellenrieder Prof. Santos Miguel Orozco Soto - Facoltà di Ingegneria Tel. : +39 E-mail: Web:
Scientific sector of the lecturer	IINF-04/A – Systems and Control Engineering
Teaching language	English
Office hours	As listed on Teams or by appointment
Teaching assistant (if any)	TBD
Office hours	As listed on Teams or by appointment

List of topics covered	1. Modelling and systems analysis in state space (dynamic system modelling in time domain and state-space representation). 2. Dynamic system response derived from state-space representation and steady-state error. 3. Stability in state space. 4. Control design in state space (Pole placement design techniques; controllability, observability, full-state observers). 5. Optimal control of dynamic systems (Problems with fixed and variable end-points as well as with equality and inequality constraints; maximum principle and Hamilton-Jacobi-Bellmann equation; linear quadratic regulator). 6. Understanding of observers in control systems. 7. Understanding of optimal state observers and Kalman filters. 8. Computer-aided analysis and design using Matlab/Simulink. 9. Implementation of controllers and experimental evaluation on real-hardware setups.
Teaching format	Lessons are divided into i) theoretical classroom lessons, ii) classroom exercises, and iii) lab exercises.

Learning outcomes (ILOs)	<u>Knowledge and understanding</u> Knowledge and understanding in the field of: 1. State-space modelling and control 2. Optimal control 3. Observers <u>Applying knowledge and understanding</u> 4. Ability to apply knowledge for solving given problems, including solving them with numerical data using software packages like Matlab/Simulink and their implementation and evaluation on real hardware setups. <u>Making judgements</u> 5. Ability to judge plausibility of results. <u>Communication skills</u> 6. In-class exercises will require you justify your solutions/conclusions concisely (in clear and simple language). <u>Ability to learn</u> 7. Learning skills to independently study and apply methods of modern control for specific applications beyond topics covered in this lecture.

Assessment	**Formative assessment** **Form** | **%** | **Length /duration** | **ILOs assessed** Exercises | 40 | 54 hours total (lab + in class) | 1-7 **Summative assessment** **Form** | **%** | **Length /duration** | **ILOs assessed** Final Exam | 60 | 4 hours | 1-7
Assessment language	English
Evaluation criteria and criteria for awarding marks	Labs: Completeness and correctness of reports; quality of writing; level of observation of physical processes In-Class Exercises: Completeness and correctness of answers; level of understanding Written Final Exam: Completeness and correctness of answers. Students must receive an overall grade of greater than 60/100 points to pass the course.

Formative assessment

Form	%	Length /duration	ILOs assessed
Exercises	40	54 hours total (lab + in class)	1-7

Summative assessment

Form	%	Length /duration	ILOs assessed
Final Exam	60	4 hours	1-7

Required readings	Lecture notes provided
Supplementary readings	Additional books and articles may be recommended by the instructor during the course.