Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Modern Control
Course code	42412
Scientific sector	ING-INF/04
Degree	Bachelor in Electronics and Cyber-Physical Systems Engineering
Semester	II
Year	II
Academic Year	2023/24
Credits	9
Modular	//

Total lecturing hours	36
Total lab hours	54
Attendance	Recommended
Prerequisites	Lectures and exercises of Mathematical Analysis I and II, Linear Algebra, Physics I, and Physics II
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, but also in laboratory experiments on real hardware.

Lecturer	
Scientific sector of the lecturer	ING-INF/04 – AUTOMATION
Teaching language	English
Office hours	After consultation and agreement with lecturer
Teaching assistant (if any)	-
Office hours	-
List of topics covered	1. Modelling and system analysis in state space: dynamic system modelling in time domain and state-space representation, dynamic system response derived from state-space representation, stability in state space, steady-state error for systems in state space 2. Control design in state space: pole placement design techniques, controllability, observability, full-state observers 3. Optimal control of dynamic systems: problems with fixed and variable end-points as well as with equality and inequality constraints, maximum principle, Hamilton-Jacobi-Bellmann equation, linear quadratic regulator 4. Laboratory: computer-aided analysis and design using

	Matlab/Simulink, implementation of controllers and experimental evaluation on real-hardware setups
Teaching format	The lessons are divided into i) theoretical classroom lessons, ii) classroom exercises and iii) lab exercises.

Learning outcomes (ILOs)	Knowledge and understanding Knowledge and understanding in the field of: 1. State-space modelling and control 2. Optimal control Applying knowledge and understanding 3. 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. Making judgements 4. Ability to judge plausibility of results. Communication skills 5. Maturing of technical-scientific terminology. Ability to learn 6. 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
In-class exercises	Continuously as part of course-accompanying exercises	1-6

Summative assessment

Form	%	Length /duration	ILOs assessed
In-class exercises (Mid-term) *	15	120 minutes	1-6
Written	60	180 minutes	1-6
Programming	25	120 minutes	1-6

* For those students unable to attend the mid-term in-class exercise, the final written exam will account for 75% of the grade.

Assessment language	English
Evaluation criteria and criteria for awarding marks	The final exam consists of two parts.

	The first one will focus on several mathematical tasks to be solved, which are distributed among the main topics covered. Judged will be: • the correctness of the approach and the mathematical steps of the solution, the calculation of numerical results; • the correctness of the provided answers and arguments presented and the terminology used. The second part will focus on examining the ability of the student to solve a problem with the help of Matlab and Simulink. The student will have to develop a script and/or Simulink diagram and to deliver them as part of the exam. Judged will be: • the correctness of the implementation and achieved simulation results.

Required readings	Blackboard
Supplementary readings	Modern Control Engineering – International edition 5/E, Katsuhiko Ogata, Pearson, 2010. Control Systems Engineering – Global Edition, Norman S. Nise, Wiley, 2017 (based on 7th edition from 2015). Brogan, William L.. "Modern control theory (3rd ed.)." (1991). Feedback Control of Dynamic Systems – Global Edition, Gene F. Franklin, J. D. Powell, A. Emami-Naeini, Pearson, Global Edition, 2015 (based on 7th edition from 2015) Automatic Control Systems, Farid Golnaraghi, Benjamin C. Kuo, 10th Edition, Mc Graw Hill Education, 2017. Modern Control Systems, Global Edition 13/E, Dorf & Bishop, Pearson, 2018. Optimal Control with Engineering Applications, H.P. Geering, Springer, 2007.