INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Control Systems			Field of study	Automation and Control		
Bachelor in	Electrical and Computers Engineering			School	School of Technology and Management		
Academic Year	2023/2024	Year of study	2	Level	1-2	ECTS credits	6.0
Type	Semestral	Semester	2	Code	9112-742-2202-00-23		

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			15	15	30	-	-	-	-	-

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): Adriano Manuel Alves Ferreira, Getúlio Paulo Peixoto Igrejas

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Model physical systems, namely mechanical, electrical and thermal systems by establishing its differential equations and the state space equations that describe the system dynamics;
2. Find the transient response and steady-state response of first and second order systems;
3. Analyze and improve the system behavior recurring to the Root Locus analysis and Bode and Nyquist diagrams;
4. Design and implement PID controllers and Lead/lag compensators by using time domain and frequency domain techniques on continuous and discrete domains;
5. Understand the sample/hold ideal model and its effect in the control systems context;
6. Apply and understand the different methods and tools for discrete system modeling;
7. Characterize mathematically an open loop and closed loop hybrid control system on Z domain and space state;
8. Use specific software to analyze, design and simulate control systems, MATLAB.

Prerequisites

Before the course unit the learner is expected to be able to:
1. Perform differential and integral calculus;
2. Understand and calculate Laplace and Z transforms;

Course contents

Continuous domain control: Basic Concepts: stability, open loop systems, closed loop systems, Analysis and design of control systems: Root Locus, Bode diagrams and Nyquist diagrams, Lead/lag compensator and PID controllers; Discrete control: Sampling and reconstruction, Z transform, S to Z plane mapping, Sampling period, Digital control systems analysis, Design of digital PID controllers.

Course contents (extended version)

1. Continuous time control
   - Basic Concepts: Stability, Performance characterization, Steady state performance criteria;
   - Time domain specifications, Frequency domain specifications;
   - First order open loop systems, Second order open loop systems;
   - Feedback systems, Closed loop sensibility, Steady state error;
   - First order closed loop systems, Second order closed loop systems;
   - Open loop vs closed loop;
   - Control system design: Root locus, Bode diagrams;
   - PID controllers tuning, Ziegler and Nichols method;
   - Bode diagrams design;
   - Lead Lag compensator design;
2. Discrete control
   - Sampling process, Sampling distortion aspects, Quantification;
   - Reconstruction, Ideal reconstruction, Real reconstruction, ZOH dynamic effect;
   - Z transform, Inverse Z transform and diference equation;
   - Discrete system frequency response, Geometric evaluation of the frequency response;
   - Discrete systems stability;
   - Continuous transfer functions discretization, Euler Forward e Backward, Bilinear transformation;
   - Digital control systems analysis: Open loop sampled systems, Closed loop sampled systems;
   - Stability analysis techniques, Discrete systems Routh-Hurwitz criteria, Jury criteria;
   - Digital controller design: Zero order hold effect, Anti-aliasing filter effect, Design by emulation;

Recommended reading

1. K. Ogata, Modern Control Engineering, Prentice-Hall, 2001
2. D'Azzo, J. , Linear Control Systems Analysis and Design: Conventional and Modern, McGraw-Hill, 1975
3. Houpis, C. , Lamont, G. , Digital Control Systems: Theory, Hardware, Software, McGraw-Hill, 1992
4. The Mechatronics Handbook, CRC Press, 2002
5. Kilian, C. , Modern Control Technology, Thomson Delmar Learning, 2006

Teaching and learning methods

Theoretical lessons: Theoretical concepts presentation. Presentation, analysis and discussion of some application examples. Exercises. MATLAB simulation practical examples. Laboratory lessons: Support and orientation to the final work.
Theoretical classes are taught in Portuguese. Laboratory classes in Portuguese with English support.

Assessment methods

1. Written exam + Project - (Regular, Student Worker) (Final, Supplementary, Special)
   - Practical Work - 60% (It consists of a single piece of work to be carried out during the semester in laboratory classes;)
   - Final Written Exam - 40% (Minimum of 7 (seven, in a scale of twenty);)
2. Written exam - (Student Worker) (Final, Supplementary, Special)
   - Final Written Exam - 100% (Minimum of 9.5/20;)
3. Mobility Students - (Regular, Student Worker) (Final, Supplementary, Special)
   - Projects - 100% (Applies only to non-Portuguese-speaking mobile students.)

Language of instruction

Portuguese

Electronic validation

Adriano Manuel Alves Ferreira, Getúlio Paulo Peixoto Igrejas	José Augusto de Almeida Pinheiro Carvalho	José Luís Sousa de Magalhaes Lima	José Carlos Rufino Amaro
06-03-2024	06-03-2024	06-03-2024	09-03-2024