Course guide
19614 - MCS - Modern Control Systems

Last modified: 09/06/2023

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.

Degree: MASTER'S DEGREE IN AEROSPACE SCIENCE AND TECHNOLOGY (Syllabus 2015). (Optional subject).
MASTER'S DEGREE IN AEROSPACE SCIENCE AND TECHNOLOGY (Syllabus 2021). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Defined in the course webpage at the EETAC website

Others: Defined in the course webpage at the EETAC website

PRIOR SKILLS

Linear algebra. Basic programming skills in MATLAB/Simulink

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE1 MAST21. Apply the scientific method to the study of the particular phenomenology of the aerospace environment.
CE2 MAST21. Apply systems engineering in the aerospace environment for the design and management of the different technological aspects associated with a mission.

Generical:
CG2 MAST. Identify and apply the fundamental theoretical, experimental and numerical analyzes currently used in aerospace engineering.

Transversal:
CT2. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Basic:
CB6. Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context.
CB7. Students will be able to apply the acquired knowledge and their ability to solve problems in new or little explored environments in broader (or multidisciplinary) contexts related to their study area.
CB8. Students will be able to integrate knowledge and face the complexity of formulating judgments based on information that, while being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and opinions.
CB10. Students will acquire learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

TEACHING METHODOLOGY

Autonomous work. Theory lessons. Laboratory sessions. Problem-based sessions.

LEARNING OBJECTIVES OF THE SUBJECT

- Understand the different constituent elements of a control system
- Characterisation of the dynamics of a system and its temporal response
- Basic skills in design of control systems
- Advanced techniques and applications in different fields

STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	36.00
Self study	80,0	64.00

Total learning time: 125 h

CONTENTS

Modern Control Systems

Description:
1. Architecture of control systems:
o Open and closed loop architectures. Control variables. Feedback.

2. Dynamic models and time response:
o Modeling mechanical, electrical, electromechanical and fluid systems.
o Analysis of the transient and stationary response. Laplace transform, z-transform. Transfer function.

3. Standard controller design methods:
o The root-locus method. Design by frequency techniques. Bode and Nyquist plots.

4. State-space methods:
o State-Space models, design of state-feedback controllers. Controllability.

5. Estimator design:
o Estimation of state variables. Observability. Kalman filters.

6. Optimal and robust and adaptive control:
o Quadratic cost functions. Linear-quadratic regulator (LQR). Linear-quadratic Gaussian control (LQG). Robust control. H-infinity methods.

7. Control of nonlinear systems:
o Introduction to nonlinear dynamical and chaotic systems. Typical nonlinearities. Linearization. The describing function method. Particle filters

8. Intelligent control and machine learning:
o Evolutionary and Genetic Algorithms. Fuzzy Logic. Neural Networks and Deep Learning

Full-or-part-time: 48h
Theory classes: 45h
Guided activities: 3h

GRADING SYSTEM

Defined in the course webpage at the EETAC website

BIBLIOGRAPHY

Basic:
- Nise, Norman S. Control systems engineering. 6th ed., international student version. Hoboken: John Wiley & Sons, cop. 2011. ISBN 9780470646120.
- Franklin, Gene F; Powell, J. David; Emami-Naeini, Abbas. Feedback control of dynamic systems. 3rd ed. Reading, Mass. [etc.]: Addison-Wesley, cop. 1994. ISBN 0201527472.
- Ogata, Katsuhiko. Modern control engineering [on line]. 4th ed. Englewood Cliffs, NJ: Prentice-Hall, cop. 2002 [Consultation: 26/07/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1259. ISBN 0130609072.
- Nise, Norman S. Control systems engineering. 6th ed., international student version. Hoboken: John Wiley & Sons, cop. 2011. ISBN 9780470646120.
- Franklin, Gene F; Powell, J. David; Emami-Naeini, Abbas. Feedback control of dynamic systems. 7th ed. Upper Saddle River [etc.]: Pearson, cop. 2015. ISBN 9781292068909.