



Course guides

230121 - EPSC - Power Electronics and Control Systems

Last modified: 29/04/2020

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.

Degree: BACHELOR'S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Optional subject).

Academic year: 2020 **ECTS Credits:** 7.0 **Languages:** English, Spanish

LECTURER

Coordinating lecturer: Biel Sole, Domingo
Guinjoan Gispert, Francisco Juan

Others: Biel Sole, Domingo
Guinjoan Gispert, Francesc
Dominguez Pumar, Manuel

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Generical:

10 ECI N3. They will have acquired knowledge related to experiments and laboratory instruments and will be competent in a laboratory environment in the ICC field. They will know how to use the instruments and tools of telecommunications and electronic engineering and how to interpret manuals and specifications. They will be able to evaluate the errors and limitations associated with simulation measures and results.

TEACHING METHODOLOGY

Regular class of theory and problems

Written exams:

- 1) Mid course exam
- 2) Final exam

Lab work.

LEARNING OBJECTIVES OF THE SUBJECT

Introducing the principles of design of linear control techniques in continuous and discrete time systems and its application to physical systems, focusing in electronic and electromechanical ones

Knowing CAD tools to design and implement controllers to control electronic and electromechanical systems. Applying experimental techniques for the validation of the performance of control systems.

Design oriented analysis, implementation and experimental verification of electrical power conversion circuits and their industrial applications in electronic and electromechanical equipment power supply, communication systems and renewable energy.

STUDY LOAD

Type	Hours	Percentage
Hours large group	52,0	29.71
Self study	97,0	55.43
Hours small group	26,0	14.86

Total learning time: 175 h

CONTENTS

Introduction to linear control systems

Description:

- Basic components of a control system, reference, control, output and disturbance signals.
- Control system goals.
- Continuous-time control and discrete-time control.
- Dynamic systems classification: linear and nonlinear systems, time-varying and time-invariant systems.
- Transfer function of linear systems.

Full-or-part-time: 8h

Theory classes: 2h

Laboratory classes: 2h

Self study : 4h

Continuous-time control systems analysis

Description:

- Transient and steady-state time-response of linear systems.
- First and second-order systems.
- Transient response characterization: settling time, maximum overshoot, etc.
- Higher order systems: transient response approximation through dominant poles and zero-pole cancellation.
- Routh-Hurwitz stability criteria.
- Root locus analysis.
- Steady-state error.

Full-or-part-time: 16h

Theory classes: 6h

Laboratory classes: 2h

Self study : 8h

Continuous-time control systems design

Description:

- Control design through root locus.
- First and second-order controllers.
- PID controllers.
- Implementation issues of PID controllers.

Full-or-part-time: 18h

Theory classes: 6h

Laboratory classes: 2h

Self study : 10h



Analysis of control systems in frequency domain

Description:

- Frequency response of linear systems.
- Nyquist diagram and Bode diagram.
- Relative stability: gain margin and phase margin.

Full-or-part-time: 14h

Theory classes: 4h

Laboratory classes: 2h

Self study : 8h

Frequency-domain control design

Description:

- Frequency-domain specifications: relative stability margins and bandwidth of a control system.
- Lead-lag and phase-lag compensations.

Full-or-part-time: 16h

Theory classes: 4h

Laboratory classes: 2h

Self study : 10h

Discrete-time control systems

Description:

- Introduction to discrete-time control systems.
- The Z transform.
- Z Plane analysis of discrete-time systems.
- Design of discrete-time control systems by conventional methods.

Full-or-part-time: 16h

Theory classes: 4h

Laboratory classes: 3h

Self study : 9h

Introduction to Power Electronics: power conversion circuits

Description:

Sources, loads and storage systems electrical characteristics. Power conversion types. Elemental power conversion circuits. Power devices and ancillary circuits.

Full-or-part-time: 9h

Theory classes: 3h

Self study : 6h



Steady-state analysis and design of power converters

Description:

Steady-state specifications of power converters. Components design.

Full-or-part-time: 24h

Theory classes: 7h

Laboratory classes: 4h

Self study : 13h

Dynamical modelling and control of power converters

Description:

Controlled sources modelling of switches. PWM modelling. Transfer functions and control design.

Full-or-part-time: 23h

Theory classes: 7h

Laboratory classes: 4h

Self study : 12h

Modelling and design of magnetic devices

Description:

Equivalent magnetic circuits. Reluctance and gap concept. Inductors and transformers design.

Full-or-part-time: 9h

Theory classes: 3h

Laboratory classes: 1h

Self study : 5h

Applications of power electronics: power supply of electronic devices, communications renewable energy based systems.

Description:

Switching regulators design for electronic devices power supply. battery chargers, photovoltaic applications

Full-or-part-time: 22h

Theory classes: 6h

Laboratory classes: 4h

Self study : 12h

GRADING SYSTEM

Written exams:

- 1) Mid course exam
- 2) Final exam

Lab work: evaluation of lab work

Final Mark= $0.3 \cdot (\text{lab work}) + 0.7 \cdot \max \{ \text{Final Exam Mark}; 0.7 \cdot \text{Final Exam Mark} + 0.3 \cdot \text{Mid Course Exam Mark} \}$

This course will also assess on the following skills:

- Ability to identify, state and solve engineering problems (High level)
- Instrumentation knowledge and experimental skills (High level)

BIBLIOGRAPHY

Basic:

- Ogata, K. Ingeniería de control moderna [on line]. 5a ed. Madrid [etc.]: Pearson Educación, 2010 [Consultation: 10/05/2020]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1259. ISBN 9788483226605.
- Åström, K.J; Murray, R.M. Feedback systems : an introduction for scientists and engineers. Princeton: Princeton University, 2008. ISBN 9780691135762.
- Kassakian, J.G; Schlecht, M.F.; Verghese, G.C. Principles of power electronics. Reading: Addison-Wesley, 1991. ISBN 0201096897.
- Golnaraghi, F.; Kuo, B.C. Automatic control systems. 9th ed. New York: John Wiley & Sons, 2010. ISBN 9780470048962.
- Erickson, R.W; Maksimovic, D. Fundamentals of power electronics [on line]. 2nd ed. Dordrecht: Kluwer Academic Publishers, 2001 [Consultation: 09/07/2015]. Available on: <http://link.springer.com/book/10.1007/b100747/page/1>. ISBN 0792372700.