

230676 - PCRES - Power Control for Renewable Energy Systems

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2017
Degree: DEGREE IN ELECTRONIC ENGINEERING (Syllabus 1992). (Teaching unit Optional)
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2009). (Teaching unit Optional)
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Teaching unit Optional)
ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: FRANCESC GUINJOAN
Others: DOMINGO BIEL SOLÉ, ALBERTO POVEDA, EDUARD ALARCÓN

Degree competences to which the subject contributes

Transversal:

1. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
2. 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.

Teaching methodology

- Lectures
- Application classes
- Group work (distance)
- Individual work (distance)
- Exercises
- Oral presentations
- Other activities

Learning objectives of the subject

Learning objectives of the subject:

The objective of the course is to introduce several advanced control techniques and their application to the power processing control involved in renewable energy systems.

Learning results of the subject:

- Ability to describe the suitable tools leading to the dynamical models of the power processors involved in the photovoltaic and wind energy conversions to electrical power.
- Ability to analyze the control problems related with photovoltaic and wind energy conversions in different power processing scenarios (stand-alone systems, grid connected systems etc.)
- Ability to apply several nonlinear control techniques (nonlinear feedback for global linearization, energy balance techniques (passivity), variable-structure systems based techniques (sliding mode control) and fuzzy control) to solve the control problems involved in the photovoltaic and wind energy conversion systems.
- Ability to compare the features of the advanced controllers with those resulting from classical ones. This comparison will lead to establish several criteria to the selection of the most suitable controllers.



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- Ability to develop techniques for the design, analysis and evaluation of electronic systems in applications such as automation, aerospace, energy distribution and generation, consumer electronics, biomedicine, etc.
- Ability to analyze, design and evaluate electronic systems for power control and energy conversion.

Study load

Total learning time: 125h	Hours large group:	39h	31.20%
	Hours medium group:	0h	0.00%
	Hours small group:	0h	0.00%
	Guided activities:	0h	0.00%
	Self study:	86h	68.80%

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Content

<p>1. Power conversion in renewable energy systems. Control requirements.</p>	<p>Learning time: 9h Theory classes: 3h Self study : 6h</p>
<p>Description:</p> <ul style="list-style-type: none"> - Renewable energy sources. - Power conversion involved in renewable energy systems 	
<p>2. Nonlinear control techniques in power electronics</p>	<p>Learning time: 67h Theory classes: 21h Self study : 46h</p>
<p>Description:</p> <ul style="list-style-type: none"> - Dynamical behaviour of switched power conversion systems. Modelling and control problems. - State-space dynamical models. Definitions: state variables, state-space, equilibrium points. Application to basic switched converters. - Lyapunov stability criteria: local and global stability. - Variable-structure systems control. ("Sliding-Mode Control") - Fuzzy control for switched power converters. - Passivity-based Control 	
<p>3. Advanced controllers design for photovoltaic conversion systems</p>	<p>Learning time: 49h Theory classes: 15h Self study : 34h</p>
<p>Description:</p> <ul style="list-style-type: none"> - Power conversion scenarios: power conversion elements involved in stand-alone and grid-connected PV systems. - Power conversion chain modelling in PV systems. - Control goals in PV systems. - Maximum Power Point Tracking (MPPT) of PV arrays. - Quality factors in grid-connected PV systems. Inverters and modular systems. - Voltage regulators, batteries, and battery chargers. - Design of controllers: <ul style="list-style-type: none"> - Control design based on linear techniques. - Control design based on advanced nonlinear techniques. 	



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Planning of activities

EXERCISES

Description:

- Exercises on linear control design of a battery charger from PV panels.
- Exercises on nonlinear control design of a battery charger from PV panels.
- Power management of PV grid-connected system with AC and DC loads.

ORAL PRESENTATION

Description:

Presentation of a work group

Qualification system

Individual assessments: from 20% to 40%

Group assessments: from 60% to 80%

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Bibliography

Basic:

Fundamentos, dimensionado y aplicaciones de la energía solar fotovoltaica. [ed. act.]. Madrid: Ministerio de Ciencia y Tecnología : Ciemat, 2006. ISBN 8478345140.

Complementary:

Khalil, H.K. Nonlinear systems. 3rd ed. Upper Saddle River, NJ: Prentice-Hall, 2002. ISBN 0130673897.

Sabanovic, A.; Fridman, L.M.; Spurgeon, S. (eds.). Variable structure systems: from principles to implementation. London: IEE Control Series, 2004. ISBN 0-86341-350-1.

Driankov, D.; Hellendoorn, H.; Reinfrank, M. An introduction to fuzzy control. 2nd ed. Berlin: Springer Verlag, 1996. ISBN 3540606912.

Wang, L.X. A Course in fuzzy systems and control. Upper Saddle River, NJ: Prentice Hall, 1997. ISBN 0135408822.

Passino, K. M.; Yurkovitch, S. Fuzzy control. Menlo Park: Addison Wesley, 1998. ISBN 020118074X.

Ortega, R.; Loria, A.; Nicklasson, P. J.; Sira-Ramirez, H. Passivity-based control of Euler-Lagrange systems: mechanical, electrical and electromechanical applications. London: Springer-Verlag, 1998. ISBN 1852330163.

Schaft, A.J. van der. L2-gain and passivity techniques in nonlinear control. London: Springer, 2000. ISBN 1852330732.

Strong, S.J.; Scheller, W.G. The solar electric house: energy for the environmentally-responsive, energy-independent home. Still River, Massachusetts: Sustainability Press, 1993. ISBN 0-9637383-2-1.

Lorenzo, E. [et al.]. Solar electricity : engineering of photovoltaic systems. Madrid: Polytechnic University of Madrid, Institute of Solar Energy, 1994. ISBN 84-86505-55-0.

Erickson, R.W.; Maksimovic, D. Fundamentals of power electronics [on line]. 2nd ed. Dordrecht: Kluwer Academic Publishers, 2001 [Consultation: 11/02/2015]. Available on: <<http://link.springer.com/book/10.1007/b100747/page/1>>. ISBN 0792372700.

McEvoy, A.; Markvart, T.; Castañer, L. (eds.). Practical handbook of photovoltaics: fundamentals and applications. 2nd ed. Amsterdam: Academic Press, 2011. ISBN 9780123859341.

Utkin, V.I.; Guldner, J.; Shi, J. Sliding mode control in electro-mechanical systems. 2nd ed. Boca Raton, FL: CRC Press, 2009. ISBN 9781420065602.

Others resources:

Course slides. Technical papers provided.