ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

53001541 - Modelling And Control Of Power Converters

DEGREE PROGRAMME

05BG - Master Universitario en Electronica Industrial

ACADEMIC YEAR & SEMESTER

2020/21 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	53001541 - Modelling And Control Of Power Converters
No of credits	3 ECTS
Type	Optional
Academic year ot the programme	First year
Semester of tuition	Semester 1
Tuition period	September-January
Tuition languages	English
Degree programme	05BG - Master Universitario en Electronica Industrial
Centre	05 - Escuela Tecnica Superior de Ingenieros Industriales
Academic year	2020-21

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Pedro Alou Cervera (Subject coordinator)		pedro.alou@upm.es	Sin horario. Solicitar cita previa por correo electrónico
Maria Regina Ramos Hortal		regina.ramos@upm.es	Sin horario. Solicitar cita previa por correo electrónico

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

The subject - recommended (passed), are not defined.

3.2. Other recommended learning outcomes

- Circuit Analysis

- Linear Control Theory

- Power Electronics

4. Skills and learning outcomes *

4.1. Skills to be learned

CB07 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio

CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo

CE01 - Comprender, diseñar y analizar sistemas y componentes electrónicos en el ámbito de la electrónica industrial. Modelización y caracterización de sistemas electrónicos complejos.

CE04 - Utilización de herramientas CAD para la simulación, modelado y diseño de circuitos electrónicos industriales con altas prestaciones y/o restricciones

CG01 - Haber adquirido conocimientos avanzados y demostrado, en un contexto de investigación científica y tecnológica o altamente especializado, una comprensión detallada y fundamentada de los aspectos teóricos y prácticos y de la metodología de trabajo en uno o más campos de estudio

CG07 - Ser capaces de asumir la responsabilidad de su propio desarrollo profesional y de su especialización en uno o más campos de estudio.

CT01 - Uso de la lengua inglesa

CT04 - Organización y planificación

CT05 - Gestión de la información

4.2. Learning outcomes

RA18 - Aplicar criterios de estabilidad a sistemas de control para convertidores de potencia

RA17 - Desarrollar modelos de convertidores para diseñar el control teniendo en cuenta las especificaciones dinámicas del Sistema

RA19 - Simular y validar el modelo y el funcionamiento de un convertidor de potencia en lazo cerrado

RA20 - Analizar y comparar distintas técnicas de control

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

The first topic review frequency response of linear systems and the design of controllers in the frequency domain. Fundamental limits of controller due to the plant are also reviewed.

The second topic covers the modeling of power converters applying the concept of averaging. This technique will allow removing the time-variant property of switched converters and it will simplify its analysis from the dynamic point of view.

In the third chapter the most common control techniques for DC-DC converters are covered.

The last topic is focused on the impact of EMI input filters on the control and provides tools for the design of the input filters. System stability is also covered using the same concepts.

The topic of computer aided design tools is covered along the course by doing practical exercices with computers during the explanation of the different concepts.

5.2. Syllabus

1. Basic Concepts
    1.1. Frequency Response
    1.2. Fundamental limits of Control
2. Averaged Modeling
    2.1. State-space averaging
    2.2. Circuit Averaging
    2.3. Peak current mode modeling
3. Control of power converters
    3.1. Averaged control
    3.2. Peak current mode control
4. Advanced Topics
    4.1. Extra-Element Theorem
    4.2. Input Filter Design
    4.3. System stability
5. Computer aided design tools
    5.1. Simulation of power converters
    5.2. Analysis of main transfer functions
    5.3. Loop Gain Analysis

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Distant / On-line	Assessment activities
1	**T1 Introduction, goals, content, methodology** Duration: 03:00			
2	**T1 Fundamentals: Bode plots, limits of Control** Duration: 03:00			**HW1 Controller Design** Continuous assessment and final examination Not Presential Duration: 02:00
3		**T5 Simulation of Power Converters** Duration: 03:00		**HW2 Buck converter simulation** Continuous assessment and final examination Presential Duration: 02:00
4	**T2 State space averaging** Duration: 03:00			
5	**T2 Circuit Averaging** Duration: 03:00			
6	**T3 Voltage Mode Control** Duration: 02:00	**T5 Simulation Voltage Mode Control** Duration: 02:00		**HW3 Voltage Mode Controller Design** Continuous assessment and final examination Presential Duration: 02:00
7	**T2 Discontinuous Conduction Mode** Duration: 02:00			
8	**Modeling Peak Current Mode Control** Duration: 02:00			
9		**T5 Example BOOST Peak Current Mode** Duration: 02:00		**HW4 Boost Peak Current Mode** Continuous assessment and final examination Presential Duration: 02:00
10	**T5 Extra Element Theorem** Duration: 02:00			

11	**T5 Input filter design** Duration: 02:00			
12		**Example Input filter design and simulation** Duration: 02:00		**HW5 Input Filter Design** Continuous assessment and final examination Presential Duration: 02:00
13	**Resonant Converters** Duration: 02:00			
14				
15				
16				
17				**Final Exam** Continuous assessment and final examination Presential Duration: 02:00

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
2	HW1 Controller Design		No Presential	02:00	4%	5 / 10	CG01 CB10 CT01 CE01 CT05 CB07 CT04
3	HW2 Buck converter simulation		Face-to-face	02:00	4%	5 / 10	CG01 CG07 CB10 CT01 CE01 CE04 CT05 CB07 CT04
6	HW3 Voltage Mode Controller Design		Face-to-face	02:00	4%	5 / 10	CG07 CB10 CT01 CE01 CE04 CT05 CB07 CT04
9	HW4 Boost Peak Current Mode		Face-to-face	02:00	4%	5 / 10	CG01 CG07 CB10 CT01 CE01 CE04 CT05 CB07 CT04

12	HW5 Input Filter Design		Face-to-face	02:00	4%	5 / 10	CG01 CG07 CB10 CT01 CE01 CE04 CT05 CB07 CT04
17	Final Exam		Face-to-face	02:00	80%	5 / 10	CG07 CB10 CT01 CE01 CT05

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
2	HW1 Controller Design		No Presential	02:00	4%	5 / 10	CG01 CB10 CT01 CE01 CT05 CB07 CT04
3	HW2 Buck converter simulation		Face-to-face	02:00	4%	5 / 10	CG01 CG07 CB10 CT01 CE01 CE04 CT05 CB07 CT04
6	HW3 Voltage Mode Controller Design		Face-to-face	02:00	4%	5 / 10	CG07 CB10 CT01 CE01 CE04 CT05 CB07 CT04
9	HW4 Boost Peak Current Mode		Face-to-face	02:00	4%	5 / 10	CG01 CG07 CB10 CT01 CE01 CE04 CT05 CB07 CT04

12	HW5 Input Filter Design		Face-to-face	02:00	4%	5 / 10	CG01 CG07 CB10 CT01 CE01 CE04 CT05 CB07 CT04
17	Final Exam		Face-to-face	02:00	80%	5 / 10	CG07 CB10 CT01 CE01 CT05

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

Along the course there will be provided some homework activities with a fixed deadline.

These activities will allow the students to increase their final grade up to 2 points.

All the students must do the final written examination.

In order to pass the subject a minimum of 5 out of 10 must be obtained in the final exam.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Fundamentals of Power Electronics	Bibliography	Reference book
Slides	Bibliography	Slides with the main contents of the classes
SIMPLIS/SIMETRIX	Others	Circuit Simuation Software for the analysis os switched mode power converters
Computers	Equipment	Computers for simulations
MATLAB/Simulink	Others	Software for desing and simulation of controllers

9. Other information

9.1. Other information about the subject

La asignatura se relaciona con el ODS7 desde el punto de vista de la eficiencia energética en la conversión y gestión de energía eléctrica mediante circuitos electrónicos.