COMILLAS UNIVERSIDAD PONTIFICIA ICAI ICADE CIHS

Syllabus
2022 - 2023

GENERAL INFORMATION

Data of the subject	
Subject name	Power Electronics
Subject code	DEA-GITT-423
Mainprogram	Bachelor's Degree in Engineering in Telecommunication Technologies
Involved programs	Grado en Ingeniería en Tecnologías de Telecom. y Grado en Análisis de Negocios/Business Analytics [Fourth year] Grado en Ingeniería en Tecnologías de Telecom. y Grado en Análisis de Negocios/Business Analytics [Fourth year] Grado en Ingeniería en Tecnologías de Telecomunicación [Fourth year]
Level	Reglada Grado Europeo
Quarter	Semestral
Credits	4,5 ECTS
Type	Compulsory
Department	Department of Electronics, Control and Communications
Coordinator	Jaime de la Peña Llerandi
Office hours	Appointment required

Teacher Information	
Teacher	
Name	Jaime de la Peña Llerandi
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Teacher	
Name	Johel Jose Rodriguez D'Derlee
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DESCRIPTION OF THE SUBJECT

Contextualization of the subject

Prerequisites

An elementary course in dc and ac electrical circuits

Course contents

Contents

The subject of the curse is articulated around the generation and use of electrical energy with the help of power electronics, with special emphasis on the power supply of communication devices and information processing.

1: Introduction

UNIT 1: INTRODUCTION

1.1 The importance of energy in the information society.

1.2 What is power electronics?

1.3 Applications: DC-DC, AC-DC, DC-AC, AC-AC

2: Power electronic converters

UNIT 2: DC-DC CONVERTERS

2.1 Principles. The power transistor. Average and effective value. DC-DC step-down converter in permanent regime: Waveforms.

2.2 DC-DC step down: Calculation of the fundamental magnitudes. Uninterrupted driving vs interrupted conduction mode. Dimensioning. Losses.

2.3 DC-DC step up and step up step down: Waveforms and calculation of fundamental magnitudes. General procedure for the analysis of the permanent regime. Four-quadrant DC-DC converter.

2.4 Model in average variables of a reducing DC-DC converter. Introduction to the problem of controlling a DC-DC converter.

UNIT 3: DC-DC CONVERTERS WITH GALVANIC ISOLATION

3.1 Principles of magnetic circuits.

3.2 Flyback converter: steady state analysis, waveforms and dimensioning.

3.3 DC-DC forward converter: steady state analysis, waveforms and dimensioning

UNIT 4: AC-DC CONVERTERS. RECTIFIERS

4.1 Introduction to rectifier circuits. Power factor and THD. Harmonics in electrical systems.

4.2 Uncontrolled single-phase double-wave rectifier: Analysis and dimensioning. LC filter and C filter.

4.3 Controlled single-phase rectifiers.

4.4 Power factor correction.

4.5 Three-phase rectifiers.

UNIT 5: DC-AC CONVERTERS. INVESTERS

5.1 DC-AC conversion principles: current sources and voltage sources.

5.2 DC-AC single-phase and three-phase voltage source converters: Analysis and dimensioning. PWM. Uninterruptible power supplies.

3: Electric power

UNIT 6: ELECTRICAL ENERGY AND THE ENVIRONMENT

6.1 Introduction to electrical power systems.

6.2 Conventional power generation.

6.3 Non-conventional electricity generation: photovoltaic, wind and fuel cells.

6.4 Conventional generation vs distributed generation. The role of power electronics.

4: Complementary topics

UNIT 7: ELECTROMAGNETIC COMPATIBILITY

7.1 Electromagnetic disturbances due to power electronics. Classification.

7.2 Common mode and differential mode conducted disturbances. Fundamentals and measurement. Broadband and narrowband signals.

7.3 Electromagnetic compatibility regulations: principles and examples

7.4 Conventional generation vs distributed generation. The role of power electronics.

UNIT 8: MODELING AND CONTROL OF DC-DC CONVERTERS

8.1 Model in average variables of a step down DC-DC converter.

8.2 Introduction to the control of switching DC-DC converter.

8.3 Alternatives for the control of switching power supplies.

8.4 Electronic circuits for the control of switching power supplies.

LABORATORY PROGRAM

Laboratory

- Power electronics simulation.
- Study of a DC-DC converter in permanent regime.
- Study of a DC-DC converter in transient regime.
- Study of a switching power supply.

EVALUATION AND CRITERIA

Evaluation activities	Evaluation criteria	Weight
Final exam	• Understanding of concepts. • Application of concepts to the resolution of practical problems. • Analysis and interpretation of results. • Presentation and written communication.	60 %

Problem- or case-type, follow-up tests	• Understanding of concepts. • Application of concepts to solve practical problems. • Analysis and interpretation of results. • Presentation and written communication.	20 %
Evaluation of the laboratory work and questions about it in the final exam.	• Oral and written presentation and communication. • Understanding of concepts. • Application of concepts to the resolution of practical problems and laboratory practices. • Analysis and interpretation of the results obtained in problem solving and laboratory practices. • Initiative.	20 %

Grading

Regular exam

To pass the course it is necessary to obtain 5 points or more according to the following calculation:

60% overall theoretical examination of the subject.

10% evaluation of the laboratory work and the corresponding notebook.

10% Individual question/s about the laboratory, in the final exam.

20% Follow-up tests

Note: In order to carry out the above calculation, it is necessary to obtain 4 points or more in the global theoretical exam of the subject. Otherwise, the grade of the subject will be the one obtained in the exam.

Important Note:

Class attendance is mandatory, according to the Academic Regulations of the School of Engineering (ICAI). Attendance requirements will be applied independently for theory and laboratory sessions.

In the case of theory sessions, failure to comply with this rule may prevent the student from taking the exam in the ordinary exam session.

In the case of laboratory sessions, failure to comply with this rule may prevent the student from taking the exam in the ordinary and extraordinary exams. In any case, unexcused absences to laboratory sessions will be penalized in the evaluation.

Extraordinary exam

To pass the course it is necessary to obtain 5 points or more according to the following calculation:

60% global theoretical exam of the course.

10% evaluation of the work in the laboratory during the course and the corresponding notebook.

10% Individual question/s about the laboratory, in the final exam.

20% Follow-up tests carried out during the course.

Note: In order to carry out the above calculation, it is necessary to obtain 4 points or more in the global theoretical exam of the course. Otherwise, the grade of the course will be the one obtained in the exam.

BIBLIOGRAPHY AND RESOURCES

Basic References

D.H. Hart. Power Electronics. McGraw-Hill, 2010

POWER AND ENERGY SCHEDULE

W	S	THEME	ACTIVITIES	RECOMMENDED ACTIVITIES (From course material)	In-Class work	Self-study
1	1	INTRO	An introduction to Power Electronics		3	3
	2	DC-DC	Buck Converter. Switches and Losses,			
	3		mean value and RMS value			
2	4		Buck Converter (cont.)	1.1.1 (buck)	3	9
	5		Boost converter and buck-boost	1.1.2 ,1.1.3 (buck)		
	6		Exercise buck converter	1.1.4, 1.1.5 (boost)		
3	7		Capacitor ripple in buck converter. Example of boost	1.1.11, 1.1.12(buck-boost)	3	9
	8		Example from Erickson's book	Erickson's examples		
	9		Circuits to describe losses: example with buck			
			and boost			
4	10		Transformers in DC-to-DC converters, Flyback	1.1.13	3	9
	11		and forward	1.1.14 (forward)		
	12		One example with transformer: Flyback	1.1.15 SEPIC		
5	13		QUIZ 1: DC-to-DC converters		3	3
	14		Examples for loss calculation in steady state: Cuk			
	15		Interrupted current. PWM generation. Full bridge.			
6	16	AC-DC	Rectifiers: Introduction, RMS and average values,		3	3
	17		Power Factor, and cos(phi).	2.1.1-2.1.6		
	18		output filter design	2.1.2 & 2.1.3		
7	19		Exercises with AC-DC converters	2,1,7	3	6
	20		Interrupted vs uninterrupted inductor current.	2.1.8 & 2.1.9		
	21		Review: From AC to controlled DC	2,1,10 & 2.0		
8	22	SIM	Introduction to power electronics simulation	Simulation of a	3	6
	23	SIM	in computer room	DC-to-DC converter		
	24		QUIZ 2: AC-to-DC converters			
9	25	DC-AC	Introduction to DC-AC converters		3	6
	26					
	27					
10	28	LAB1-SIM	Simulation in open loop of a buck DC-DC converter	Exercises 3.0.11 to	3	6
	29	LAB1-SIM		3.0.13 (DC-AC)		
	30		Solar and Wind generation			
11	31	LAB-2SIM	Simulation in closed loop of a buck DC-DC converter		3	6
	32	LAB-2SIM				
	33		Cont. solar and wind generation.			
12	34	LAB-3	Lab work in open loop with a buck DC-DC converter		3	6
	35	LAB-3		Read notes from Tihanyi's		
	36		Phasors and Power flow control in AC systems	Book (EMC)		
13	37	LAB-4	Lab work in closed loop with a buck DC-DC converter	Review results in lab	3	6
	38	LAB-4	Phasors and Power flow control in AC systems			
	39	EMC-I	Electromagnetic compatibility of power electronics			
14	40	DC-AC	exercises DC-AC		3	8
	41		Exercises on Power flow in AC systems			
	42		Possible QUIZ 3: DC-AC converters			
15	43	EMC	Electromagnetic compatibility of power electronics	Exercises to be proposed	3	4
	44		Review			
	45		Review			
16	46	EXAMS	EXAMS			
				Total number of hours	45	90