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E.T.S. de Ingeniería y Sistemas
de Telecomunicación

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

593000614 - Wireless Systems Manufacturing

DEGREE PROGRAMME

59AJ - Master Universitario En Comunicaciones Inalámbricas

ACADEMIC YEAR & SEMESTER

2023/24 - Semester 2

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1. Description

1.1. Subject details

Name of the subject	593000614 - Wireless Systems Manufacturing
No of credits	4.5 ECTS
Type	Optional
Academic year of the programme	First year
Semester of tuition	Semester 2
Tuition period	February-June
Tuition languages	English
Degree programme	59AJ - Master Universitario en Comunicaciones Inalámbricas
Centre	59 - Escuela Tecnica Superior De Ingeniería Y Sistemas De Telecomunicación
Academic year	2023-24

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Neftali Nuñez Mendoza (Subject coordinator)	A4205	neftali.nunez@upm.es	Sin horario. Ver en la Web https://intra.etsist.upm.es /

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

3. Skills and learning outcomes *

3.1. Skills to be learned

CB6 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación/ Students have demonstrated knowledge and understanding providing the groundwork or opportunity for innovation in developing and/or applying ideas, often within a research context

CB7 - 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/Students are capable of applying their knowledge, understanding, and problem-solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study

CB8 - Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicios/Students are capable of integrating knowledge and making complex decisions, which, although based on incomplete or limited information, require reflection on social and ethical responsibilities linked to the application of their knowledge and opinions

CGI02 - Comprender el procedimiento, valor y límites del método científico, siendo capaz de identificar, localizar y obtener datos requeridos en un trabajo de investigación, de diseñar y guiar investigaciones analíticas, de modelado y experimentales, así como de evaluar datos de una manera crítica y extraer conclusiones. / Understand the procedure, value, and limits of the scientific method, being able to identify, locate and obtain data required in a research work, to design and guide analytical, modeling, and experimental investigations, as well as to critically evaluate data and extract conclusions.

CGI03 - Valorar la importancia de las fuentes documentales, manejarlas y buscar la información para el desarrollo de cualquier trabajo de investigación. / Assess the importance of documentary sources, manage them and search for information for the development of any research work.

CGI04 - Leer y comprender publicaciones dentro de su ámbito de estudio/investigación, así como su catalogación y valor científico. / Read and understand publications within their field of study / research, as well as their cataloging and scientific value.

UPM1 - Uso de la lengua inglesa / Use of the English language

UPM4 - Organización y planificación / Planning and organization

3.2. Learning outcomes

RA35 - Enumerar y describir los componentes de un equipo de usuario para comunicaciones inalámbricas/ List and describe the components of a user equipment for wireless communications

RA36 - Elegir los métodos y herramientas informáticas necesarias para abordar la solución de un problema/ Choose the computer methods and tools necessary to tackle the solution of a problem

RA37 - Diseñar y fabricar la PCB necesaria de un equipo de usuario para comunicaciones inalámbricas/ Design and manufacture the PCB necessary of a user equipment for wireless communications

RA38 - Montar e integrar los subsistemas sobre una PCB real/ Assemble and integrate the subsystems on a real PCB

RA62 - R04 Interpret data derived from empirical observations and measurements in terms of their importance and relate them

* 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.

4. Brief description of the subject and syllabus

4.1. Brief description of the subject

The course covering this topic is aimed to address to design and develop wireless communications systems, by the interconnection of the different building blocks of a wireless communication system in the context of modern wireless devices (components, integrated circuits and systems-on-a-chip). The main technology applied for design and development will be printed circuit board (PCB), but the used of emerging PCB substrates materials and other technologies for manufacturing of wireless circuits will also be reviewed.

4.2. Syllabus

1. Introduction to PCB design for wireless systems
 - 1.1. Introduction
 - 1.2. PCB design software applications
 - 1.3. Component types and design rules
 - 1.4. Board technology and manufacturing
 - 1.5. Project management
2. PCB project of a wireless system, part 1
 - 2.1. Definition of wireless system design, part 1
 - 2.2. Signal and power integrity on a system
 - 2.3. Transmissions lines and control impedance
 - 2.4. High-frequency PCB design
 - 2.5. Wireless microcontrollers
3. Wireless system peripherals
 - 3.1. 3.1 Wireless system peripherals and connections
 - 3.2. Hardware platforms and embedded devices
4. PCB project of a wireless system, part 2

- 4.1. Project of wireless system design, part 2
- 4.2. EMI/EMC issues on a system
- 4.3. Thermal issues on a system
5. Industrialization.
 - 5.1. Design for excellence in electronics industry
 - 5.2. Program and design for reliability
 - 5.3. Design for manufacturing
6. Laboratory activity: individual work in PCB design, manufacturing and test a wireless system, part 1
7. Laboratory activity: group work in PCB project of a wireless system, part 2

5. Schedule

5.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	Lecture activity.. Sections; 1.1 Introduction 1.2 PCB design software applications 1.3 Component types and design rules Duration: 03:00	Laboratory activity. EMC PCB CAD-CAM software introduction. Duration: 01:00		
2	Lecture activity.. Sections; 1.4 Board technology and manufacturing 1.5 Project management Duration: 02:00	Laboratory activity. EMC PCB CAD-CAM software introduction. Duration: 02:00		
3	2.1 Definition of wireless system design, part 1 2.2 Signal and power integrity on a system Duration: 02:00	Laboratory activity.: EMC PCB CAD-CAM design, part 1. Duration: 02:00		
4	Lecture activity.. Sections; 2.2 Signal and power integrity on a system 2.3 Transmissions lines and control impedance Duration: 02:00	Laboratory activity.: EMC PCB CAD-CAM design, part 1. Duration: 02:00		
5	Lecture activity.. Section; 2.4 High- frequency PCB design Duration: 02:00	Laboratory activity.: EMC PCB CAD-CAM design, part 1. Duration: 02:00		
6	Lecture activity.. Sections; 2.5 Wireless microcontrollers. 3.1 Wireless system peripherals Duration: 02:00	Laboratory activity.: EMC PCB CAD-CAM design, part 1. Note: This week. Delivery of individual work design project, part 1 Duration: 02:00		
7	Lecture activity.. Sections; 3.2 Hardware platforms and Embedded device 4.1 Definition of wireless system design, part 2 Duration: 02:00	Laboratory activity.: EMC PCB CAD-CAM project, part 2 Duration: 02:00		
8	Lecture activity.. Sections; 4.2 EMI/EMC issues on a system Duration: 02:00			1º Theoretical Partial Exam 15%..Type test and short questions and problems (Units 1,2,3) Continuous assessment and final examination Not Presential Duration: 01:30

9		PCB assembly and test , part 1 Duration: 02:00		
10	Lecture activity.. Sections; 4.3 Thermal issues on a system Duration: 01:00	Laboratory activity.: EMC PCB CAD-CAM project, part 2. Duration: 01:00		
11	Lecture activity: 5.1 Design for excellence in electronics industry Duration: 01:00	Laboratory evaluation of individual work, project part 1. 25% Duration: 01:00		Laboratory evaluation of individual work, project part 1. Continuous assessment and final examination Presential Duration: 01:00
12	Lecture activity: 5.2 Program and design for reliability Duration: 01:00	Laboratory activity.: EMC PCB CAD-CAM project, part 2. Duration: 01:00		
13	Lecture activity: 5.3 Design for manufacturing Duration: 01:00	Laboratory activity.: EMC PCB CAD-CAM project, part 2. Duration: 01:00		
14	Oral presentation of laboratory group projects, part 2 Duration: 02:00			2º Theoretical Partial Exam 10%..Type test and short questions and problems (Units 4 and 5) Continuous assessment and final examination Not Presential Duration: 01:00 Laboratory Group Project: Memory and Oral Presentation, part 2, Continuous assessment and final examination Presential Duration: 02:00
15				
16				
17				

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.

6. Activities and assessment criteria

6.1. Assessment activities

6.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
8	1º Theoretical Partial Exam 15%..Type test and short questions and problems (Units 1,2,3)		No Presential	01:30	15%	0 / 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4
11	Laboratory evaluation of individual work, project part 1.		Face-to-face	01:00	50%	0 / 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4
14	2º Theoretical Partial Exam 10%..Type test and short questions and problems (Units 4 and 5)		No Presential	01:00	10%	0 / 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4
14	Laboratory Group Project: Memory and Oral Presentation, part 2,		Face-to-face	02:00	25%	0 / 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4

6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
8	1º Theoretical Partial Exam 15%..Type test and short questions and problems (Units 1,2,3)		No Presential	01:30	15%	0 / 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4
11	Laboratory evaluation of individual work, project part 1.		Face-to-face	01:00	50%	0 / 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4
14	2º Theoretical Partial Exam 10%..Type test and short questions and problems (Units 4 and 5)		No Presential	01:00	10%	0 / 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4
14	Laboratory Group Project: Memory and Oral Presentation, part 2,		Face-to-face	02:00	25%	0 / 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4

6.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

6.2. Assessment criteria

To pass the course it is necessary to attend 80% of the laboratory classes.

- Continuous evaluation.

- There are four exams/works evaluated. The set of exams/works evaluated assume 100% of the continuous evaluation.
- The two write exams, the individual laboratory hardware exposition of project part 1 and the oral group presentation of project part 2, will be developed during the usual hour class. These evaluations are planned in this guide.
- 1o the theoretical write exam, will be of type test, short questions and problems, of units 1, 2, 3. The weight of this exam is 15%.
- The 2o theoretical write exam will be of type test, short questions and problems, of units 4, 5. The weight of this exam is 10%.
- Laboratory evaluation of individual work, project part 1. This evaluation is composed of the oral hardware exam of project part 1 in the laboratory, and the evaluation of documentation, assembly, and test for this product. The weight of the complete evaluation is 25%.
- Laboratory Group Project: Memory and Oral Presentation, Part 2. This evaluation is composed of the oral presentation of the group project part 2, and the memory of the project: from the planification, schemes, design, bill of material, evaluation of issues of the product, and information needed for the manufacturer. The weight of the complete evaluation is 50%.

All evaluations are over 10 points.

For pass the course is needed an average of 5 over 10.

- Final evaluation.

For students who do not overcome the continuous evaluation. The exam date is decided by the "Jefatura de Estudios de la Escuela".

There are only three items evaluated, equivalent to continuous evaluation.

- Theoretical write exam will be of type test, short questions and problems. The weight of this exam is 20%.
- Laboratory evaluation of design abilities and practical work in manufacturing. The weight of this exam is

30%.

- Development of an individual project at the proposal of the teachers two weeks before (Moodle platform), with a memory of planning, schematic, design, and complete manufacturing instructions and a 20-minute oral presentation. The memory will be loaded into Moodle on the exam date. The weight of this assessment is 40%.

All evaluations are performed over a maximum of 10 points.

For pass the course is needed an average of 5 over 10.

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
Moodle educational platform	Web resource	Slides, examples, reports, datasheets, laboratory information
High-Speed PCB Design Guide (Sierra Circuits)	Bibliography	Access by web.
Khater, M. A. (2020). High-speed printed circuit boards: A tutorial. IEEE Circuits and Systems Magazine, 20(3), 34-45.	Web resource	Accessed by IEEE Xplore
Wilson, P. (2017). The circuit designer's companion. Newnes. 4th edition.	Bibliography	Go to O ₂ Reilly.com/library, and login as "institution not listed", then it is needed to use academic email from a UPM network or VPN-UPM. Now you have in this book with access to online content.
Brooks, D. (2003). Signal integrity issues and printed circuit board design. Prentice Hall Professional.	Bibliography	Go to O ₂ Reilly.com/library, and login as "institution not listed", then it is needed to use academic email from a UPM network or VPN-UPM. Now you have in this book with access to online content.

<p>- Video: PCB Signal Integrity LiveLessons (Video Training). By Douglas Brooks</p>	<p>Others</p>	<p>Go to O₂Reilly.com/library, and login as "institution not listed", then it is needed to use academic email from a UPM network or VPN-UPM. Now you have in this book with access to online content.</p>
<p>- Video : PCB Currents: How They Flow, How They React. By Douglas Brooks</p>	<p>Others</p>	<p>Go to O₂Reilly.com/library, and login as ?institution not listed??. then it is needed to use academic email from a UPM network or VPN-UPM. Now you have in this book with access to online content</p>
<p>Calculators & Tools, and Simulations in page: https://www.ultracad.com/index.htm ., By Douglas Brooks</p>	<p>Web resource</p>	
<p>Bogatin, E. (2018). Signal and power integrity--simplified. Pearson Education</p>	<p>Bibliography</p>	<p>Go to O₂Reilly.com/library, and login as ?institution not listed??. then it is needed to use academic email from a UPM network or VPN-UPM. Now you have in this book with access to online content</p>
<p>Bowick, C. (2011). RF circuit design. Elsevier.</p>	<p>Bibliography</p>	<p>Go to O₂Reilly.com/library, and login as ?institution not listed??. then it is needed to use academic email from a UPM network or VPN-UPM. Now you have in this book with access to online content.</p>
<p>Williams, T. (2016). EMC for product designers. Newnes. Chapter 12</p>	<p>Bibliography</p>	<p>Go to O₂Reilly.com/library, and login as ?institution not listed??. then it is needed to use academic email from a UPM network or VPN-UPM. Now you have in this book with access to online content.</p>
<p>C. Tulkoff, G. Caswell (2021) Design for Excellence in Electronics Manufacturing. John Wiley & Sons</p>	<p>Bibliography</p>	<p>Go to O₂Reilly.com/library, and login as ?institution not listed??. then it is needed to use academic email from a UPM network or VPN-UPM. Now you have in this book with access to online content.</p>

Electronics Projects with the ESP8266 and ESP32: Building Web Pages, Applications, and WiFi Enabled Devices	Bibliography	Go to O _z Reilly.com/library, and login as ?institution not listed??. then it is needed to use academic email from a UPM network or VPN-UPM. Now you have in this book with access to online content.
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8. Other information

8.1. Other information about the subject

INFORMACIÓN SOBRE ACTUACIONES EN CASO DE COPIA O PLAGIO

Los derechos y deberes de los estudiantes universitarios están desarrollados en el Estatuto del Estudiante Universitario (RD 1791/2010 de 30 de diciembre) y en el artículo 13 del referido estatuto en el punto d) especifica que es deber del estudiante universitario ***abstenerse de la utilización o cooperación en procedimientos fraudulentos en las pruebas de evaluación, en los trabajos que se realicen o en documentos oficiales de la universidad.***

En el caso de que en el desarrollo de las pruebas de evaluación se aprecie el incumplimiento de los deberes como estudiante universitario, el coordinador de la asignatura podrá ponerlo en conocimiento del Director o Decano del Centro, que de acuerdo con lo establecido en el artículo 77 (n) de los Estatutos de la UPM tiene competencias para proponer la iniciación del procedimiento disciplinario a cualquier miembro de la Escuela o Facultad, por propia iniciativa o a instancia de la Comisión de Gobierno al Rector, en los términos previstos en los estatutos y normas de aplicación.

Por lo tanto, ante tales hechos el Tribunal de la asignatura calificará con un 0 dicha prueba, al no poder determinar los conocimientos adquiridos por el alumno. Se informará a la dirección del departamento del hecho y a la Subdirección de Ordenación Académica para analizar los casos reincidentes y ponerlo en conocimiento del Director según el párrafo anterior.

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No se pueden utilizar dispositivos de comunicaciones durante la realización de las pruebas ni en clase.

English version:

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In the event that, in the course of the evaluation tests, failure to fulfil the duties as a university student is assessed, the coordinator of the subject may bring it to the attention of the Director or Dean of the Centre, who in accordance with article 77 (n) of the Statutes of the UfM has the power to propose the initiation of disciplinary proceedings to any member of the School or Faculty, on his own initiative or at the request of the "Comisión de Gobierno al Rector", in the terms provided for in the statutes and implementing rules.

Therefore, in the event of such events, the subject court shall qualify with a 0 such test, because it is unable to determine the knowledge acquired by the student. The Department's management will be informed of the incident and the Subdirectorate of Academic Management to analyse the recurring cases and bring it to the attention of the Director according to the previous paragraph.

USE OF COMMUNICATIONS DEVICES

Communications devices may not be used during testing or in class.