300029 - ER - Transmitters and Receivers

Coordinating unit: 300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications
Academic year: 2017
Degree: BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING/BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING - NETWORK ENGINEERING (AGRUPACIÓ DE SIMULTANÈITAT) (Syllabus 2015). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING/BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2015). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING/BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2015). (Teaching unit Compulsory)

ECTS credits: 4,5
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: Definit a la infoweb de l'assignatura.
Others: Definit a la infoweb de l'assignatura.

Prior skills
Linear circuits analysis (sinusoidal steady state)
Main characteristics and properties of analog electronic devices, both active and passive.
Knowledge of the properties and operation of the amplitude, frequency and phase modulation systems
Fluency in the use of a general (low-medium frequency) electronics laboratory.

Requirements
To have followed a course on:
  o Communications (analog and digital) fundamentals.

Degree competences to which the subject contributes

Specific:
1. CE 10 TELECOM. Capacidad para evaluar las ventajas e inconvenientes de diferentes alternativas tecnológicas de despliegue o implementación de sistemas de comunicaciones, desde el punto de vista del espacio de la señal, las perturbaciones y el ruido y los sistemas de modulación analógica y digital. (CIN/352/2009, BOE 20.2.2009.)
2. CE 13 TELECOM. Capacidad para comprender los mecanismos de propagación y transmisión de ondas electromagnéticas y acústicas, y sus correspondientes dispositivos emisores y receptores. (CIN/352/2009, BOE 20.2.2009.)

Genereral:
5. EFFICIENT USE OF EQUIPMENT AND INSTRUMENTS - Level 1: Using instruments, equipment and software from the laboratories of general or basic use. Realising experiments and proposed practices and analyzing obtained results.

Transversal:
3. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.
4. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
6. EFFECTIVE USE OF INFORMATION RESOURCES - Level 1. Identifying information needs. Using collections, premises and services that are available for designing and executing simple searches that are suited to the topic.

Teaching methodology

In this course the use of a RF laboratory for checking and better understanding theoretical aspects is considered as a critical part of the student education. So, once advanced the course, the autonomous access to the laboratory is encouraged.

The curse syllabus is organized in a gradual way regarding the relevance of the theoretical activities in relation with the experimental ones. First topics are theoretically introduced (intermodulation, noise, etc.) ending with a first contact with a RF laboratory, and specially with the use of an spectrum analyzer. Once made this first contact, students may carry out other experimental activities along the curse with more autonomy, as is the case of a further lab practice (RF oscillator), which aims, apart from the direct objectives to construct and measure the oscillator, to get improved knowledge on the spectrum analyzer usage.

Theoretical lectures (groups of 40 students) are based on the professor's exposition, being the formal explanations combined with a continuous asking process, targeting to make easier for students the understanding of the course fundamentals. A good motivation for the study of new concepts and techniques is a critical starting point. So, they will be introduced from their utility to solve actual problems, avoiding as possible the simple study of subjects without a clear knowledge on their usefulness. In fact, the curse is relatively short in credits, so the learning taxonomy has to be carefully selected. Hence, the presentation of the topics will be made at different speeds according to the objective, which will range from a complete operability to a simple overview. This may be also perpect in the degree of complexity of the posted problems in the website, varied among the different curse lectures.

In the lectures guided to improve practice in solving exercises and problems (groups of 20 students), students can work, depending on each particular lecture, individually or in groups of up to 3 members. The objective is to solve problems already advanced in the theoretical lectures. The professor will solve (or will give guidelines to do that) together with the students the critical parts of the problems; and additional problems to be solved at home will be proposed. It is important that the professor will not destroy the start-up of the problems, which is the most educational part of the way to the solution. Once started (or at least after elapsing a prudential time after the problem's proposal), the professor will give the abovementioned guidelines.

In the Laboratory sessions (groups of 20 students), the students will work in couples. Each member of the couple has to go to the laboratory being made, individually, the preliminary study. The practice report is one for the couple, where the work made has to be presented and results interpreted, relating them with the theoretical fundamentals (previously seen in the theoretical lectures). Main conclusions are also summarized at the end of the delivered report.

Learning objectives of the subject

- To understand the operation of a communications channel and to describe and assess some effects of non-linearities and other distortions.
- To make some kind of quality assessment of the subsystems more sensitive to noise and distortion, especially in the radiofrequency front-end.
- To compute the link-budget in a radio link, with detail of the involved noise parameters.
- To know the usual frequency bands as well as their common usage, along with some propagations aspects depending on the band.
- To know the basic operation and to choose into a catalogue usual components and subsystems in analog RF applications.
- To characterize the main kind of oscillators and mixers, and to assess the main characteristics.
- To know the main topologies for both emitters and receivers, based on the constitutive subsystems and their properties.
- To know what a PLL is and the main applications.
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- To use correctly a spectrum analyzer.
- To know main analog structures for amplitude and phase modulation and demodulation.

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group: 24h</th>
<th>21.33%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>5h</td>
<td>4.44%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>10h</td>
<td>8.89%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>10h 30m</td>
<td>9.33%</td>
</tr>
<tr>
<td>Self study:</td>
<td>63h</td>
<td>56.00%</td>
</tr>
</tbody>
</table>
# Content

## (ENG) Títol contingut 1: Communications channel. Radiofrequency head

<table>
<thead>
<tr>
<th>Learning time: 49h 18m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 12h</td>
</tr>
<tr>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td>Laboratory classes: 6h</td>
</tr>
<tr>
<td>Guided activities: 5h</td>
</tr>
<tr>
<td>Self study : 24h 18m</td>
</tr>
</tbody>
</table>

### Description:
- Interferences
- Distortion. Kinds, effects. Indicative parameters.
- Frequency bands. Use, applications. Propagation.
- Link budgets. Power and noise.

### Related activities:
- Activity 1: Workshop on intermodulation computations.
- Activity 2: Workshop on noise computations
- Activity 3: Workshop on link budgets
- Activity 4: Workshop on regulatory bodies.
- Activity 4: Short examination
- Activity 5: RF laboratory (spectrum analyzer)
**(ENG) Títol contingut 2: RF devices and circuits.**

**Description:**
REVISION OF: RF filters and applications

- Oscillators and mixers. Types, operation and descriptive parameters

At the end of the topic, the student has to be able to:
- Understand the operation and to use electronic devices in RF applications, considering the limiting effects such as non-idealities.
- To design and characterize the main kind of oscillators (LC and crystal) and mixers, to assess the properties and characteristics, as well as techniques to suppress the image frequency.

**Related activities:**
Activity 7: Workshop on CAD for filter design
Activity 8: Laboratory: RF oscillators.
HALF SEMESTER EXAMINATION
Activity 9: Short examination (RF circuits and devices)

**Learning time:** 35h 18m

- Theory classes: 8h
- Practical classes: 2h
- Laboratory classes: 4h
- Guided activities: 4h
- Self study: 17h 18m

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**(ENG) Títol contingut 3: Emitters and Receivers**

**Description:**
- PLL. Main applications.
- Control circuitry: AGC, AFC.
- Modulators and demodulators: amplitude and phase.
- Linear and switched power amplifiers. Operation principles. Biasing. Selection criteria. Introduction to linearizers and power combiners.
- To know and to choose the power amplifier suitable for different applications.

**Related activities:**
FINAL EXAMINATION. (ALL THE COURSE CONTAINS)

**Learning time:** 27h 54m

- Theory classes: 4h
- Practical classes: 1h
- Guided activities: 1h 30m
- Self study: 21h 24m
### Planning of activities

<table>
<thead>
<tr>
<th>Workshop</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>WORKSHOP ON INTERMODULATION COMPUTATIONS</td>
<td>5h 30m</td>
</tr>
<tr>
<td>Description:</td>
<td></td>
</tr>
<tr>
<td>This activity will be carried out in groups of 20 students, and it will be based either on the proposal of additional activities or to solve issues appeared when resolving the proposed exercises. The students can get individual tutoring to solve the doubts raised from the personal study of the proposed exercises, aiming at a better training for the mid semester examination.</td>
<td></td>
</tr>
<tr>
<td>Support materials:</td>
<td></td>
</tr>
<tr>
<td>The necessary support wil be given by the teacher along the session.</td>
<td></td>
</tr>
<tr>
<td>Descriptions of the assignments due and their relation to the assessment:</td>
<td></td>
</tr>
<tr>
<td>Proposed exercises on intermodulations.</td>
<td></td>
</tr>
<tr>
<td>Specific objectives:</td>
<td></td>
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<tr>
<td>Learning to compute intermodulation effects in communication receivers.</td>
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</tbody>
</table>

| WORKSHOP ON NOISE COMPUTATIONS          | 7h    |
| Guided activities:                      | 2h    |
| Self study:                             | 5h    |

| WORKSHOP ON LINK BUDGETS               | 4h    |
| Guided activities:                      | 1h    |
| Self study:                             | 3h    |

| WORKSHOP ON REGULATORY BODIES          | 4h    |
| Guided activities:                      | 1h    |
| Self study:                             | 3h    |

| SHORT ASSESSMENT ON THE COMMUNICATIONS CHANNEL | 1h    |
| Practical classes:                          | 1h    |

| LABORATORY: RF INSTRUMENTATION (SPECTRUM ANALYZER) | 8h    |
| Laboratory classes:                              | 4h    |
| Self study:                                       | 4h    |
### Half Semester Examination
- **Hours:** 1h 30m
  - Guided activities: 1h 30m

### Workshop on CAD for RF Filter Design
- **Hours:** 8h
  - Guided activities: 2h
  - Self study: 6h

### Laboratory: Design and Measurement of RF Oscillators
- **Hours:** 9h
  - Laboratory classes: 4h
  - Self study: 5h

### Short Assessment on RF Circuits and Devices
- **Hours:** 1h
  - Practical classes: 1h

### Final Semester Examination
- **Hours:** 1h 30m
  - Guided activities: 1h 30m

**Description:**
Includes all the course syllabus.

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**Qualification system**

Defined in the infowet of the course.

**Regulations for carrying out activities**

The attendance to the laboratory sessions is mandatory, as well as to make the preliminary proposed works and to deliver the reports.
Bibliography

Basic:


Complementary:


Others resources:

Sowftware. Computer aided design programs such as RFSim99, Smith, MDS,…

Audiovisual material

Nom recurs

Resource