230606 - ECS - Electronics for Communications Systems

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2018
Degree: MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional)
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Teaching unit Optional)
ECTS credits: 5
Teaching languages: English

Teaching staff
Coordinator: XAVIER ARAGONES
Others: XAVIER ARAGONES, ANTONI TURO, FRANCESC MOLL

Prior skills
The MOS transistor - Physical structure and Modeling (DC equations). Small-signal model. Concepts of operation point (quiescent point) and response to the small signal. DC and Small-signal analysis of basic analog circuits - the common-source amplifier. Circuit analysis in the Laplace domain.

Requirements
The MOS transistor - Physical structure and Modeling (DC equations). Small-signal model. Concepts of operation point (quiescent point) and response to the small signal. DC and Small-signal analysis of basic analog circuits - the common-source amplifier. Circuit analysis in the Laplace domain.

Degree competences to which the subject contributes

Specific:
1. Ability to design and manufacture integrated circuits
2. Ability to use programmable logical devices, as well as to design analog and digital advanced electronics systems. Ability to design communication devices, such as routers, switches, hubs, transmitters and receivers in different bands.
3. Ability to apply advanced knowledge in photonics, optoelectronics and high-frequency electronic
4. Ability to implement wired/wireless systems, in both fix and mobile communication environments.

Transversal:
5. 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.
6. 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.
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**Teaching methodology**

- Lectures
- Laboratory classes
- Laboratory practical work
- Individual work (distance)
- Exercises
- Extended answer test (Final Exam)

**Learning objectives of the subject**

The aim of this course is to give students an overview of the problems and issues that must be dealt with when designing circuits for communication transmitter and receiver front-ends, as well as a comprehensive overview of the basic concepts and theoretical foundation of analog/RF design in microelectronic CMOS technology. Concepts will be worked out with practical design exercises to be developed using professional circuit design CAD tools, and hands-on exercises to be developed along the course.

**Learning results of the subject**

- Understand and analyze circuit solutions to implement the different blocks that constitute the RF/analog part in communication terminals (receivers, transmitters), both wired and wireless.
- Understand the issues that pose a limitation on the operating frequency of these circuits, and the basic techniques for bandwidth extension and operation at high frequency.
- Understand and evaluate the circuit non-idealities and how affect their performance.

**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group:</th>
<th>13h</th>
<th>10.40%</th>
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<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>26h</td>
<td>20.80%</td>
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<td></td>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>86h</td>
<td>68.80%</td>
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**Content**

<table>
<thead>
<tr>
<th>1. Basic CMOS amplification circuits</th>
<th><strong>Learning time:</strong> 14h</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 14h</td>
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<tr>
<td>Basic 1-stage amplifiers: Common-source, common drain.</td>
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<td>Bias circuits: the current mirror</td>
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<td>Frequency response.</td>
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<td>Bandwidth estimation</td>
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<td>Bandwidth extension</td>
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<tr>
<th>2. Differential amplifiers</th>
<th><strong>Learning time:</strong> 24h</th>
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<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 2h</td>
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<tr>
<td>Differential amplifiers: resistive load and current mirror load. DC analysis. AC gain and BW. CMRR, PSRR and Slew-Rate.</td>
<td>Laboratory classes: 6h</td>
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<td>Self study : 16h</td>
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<tr>
<th>3. Narrowband amplifiers. Noise and Linearity.</th>
<th><strong>Learning time:</strong> 32h</th>
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<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 4h</td>
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<tr>
<td>Narrowband amplifiers - The source-degenerated resonant LNA.</td>
<td>Laboratory classes: 6h</td>
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<tr>
<td>Noise analysis in communication circuits - NF.</td>
<td>Self study : 22h</td>
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<tr>
<td>Linearity in communications systems</td>
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5. Oscillators

Description:
Definitions and figures of merit
Oscillator types: ring oscillator, relaxation, Colpitts, LC
The LC-CMOS VCO

Learning time: 18h
Theory classes: 2h
Laboratory classes: 4h
Self study: 12h

Qualification system
Final examination: 40%
Partial examinations and exercises: 20%
Laboratory assessments: 40%

Bibliography

Basic:

Others resources:
Course slides, exercises, tutorials and labs available through the Atenea virtual campus.