Course guide
300481 - DECS-OAT - Electroacoustic Devices for Communications and Sensors

Last modified: 30/06/2024

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING (Syllabus 2015). (Optional subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer: Collado Gomez, Juan Carlos

Others: Mateu Mateu, Jordi
González Arbesú, José María

PRIOR SKILLS

Ability to work with complex numbers.
Basic knowledge of electronic circuits

TEACHING METHODOLOGY

Electroacoustic devices have become a fundamental technology both in portable communications devices (quartz crystals, resonators and filters) and in the biomedical industry (gravimetric particle sensors, transducer arrays for ultrasound machines, etc.). This subject introduces the most common design, manufacturing and measurement techniques of electroacoustic devices, the different technologies with which they can be manufactured, and the nomenclature used by the industry to define their performance.
For this purpose, master classes will be taught with the support of exercises and experimental laboratory practices. In class and in the laboratory you will have the support of a professional simulator for analysis and design of radio frequency circuits. Laboratory classes will consist mainly of the design and simulation of radio frequency circuits formed by electroacoustic devices using the theoretical knowledge taught in theory class. In the laboratory, students will make reports on the work developed that will be used for the self-study task.
There will also be conferences (preferably in person) given by experts on specific topics. Specifically, collaborations are planned from the R&D department of Qorvo, Inc. in aspects of production and design process and from the EPFL in aspects related to the manufacture of electro-acoustic devices.

LEARNING OBJECTIVES OF THE SUBJECT

Electroacoustic devices have become fundamental technology in both portable communication devices (quartz crystals, resonators, and filters) and the biomedical industry (gravimetric particle sensors, transducer arrays for ultrasound scanners, etc.). This course introduces the most common design, manufacturing, and measurement techniques for electroacoustic devices, the various technologies they can be made with, and the industry's terminology to define their performance.

For this purpose, lectures will be given with the support of exercises and experimental laboratory practices. In class and in the lab, students will have access to a professional simulator for the analysis and design of radiofrequency circuits. Lab classes will primarily involve designing and simulating radiofrequency circuits composed of electroacoustic devices using the theoretical knowledge taught in the theory classes. In the lab, students will create reports on the work developed, which will aid in their self-study.

There will also be (preferably in-person) lectures given by experts on specific topics. Collaborations are planned with the R&D department of Qorvo, Inc. on production and design process aspects and with EPFL on aspects related to the manufacturing of electroacoustic devices.

STUDY LOAD

Type	Hours	Percentage
Self study	84,0	56.00
Hours large group	66,0	44.00

Total learning time: 150 h

CONTENTS

Fundamentals of piezoelectricity

Description:
The topics covered in this section are:
• Acoustic waves. Circuit equivalences
• Constitutive equations of piezoelectricity

Full-or-part-time: 37h
Theory classes: 15h
Self study : 22h

Market and applications of electroacoustic components

Description:
The topics covered in this section are:
• Applications in the communications industry
• Applications in the space industry
• Applications in the biomedical industry

Full-or-part-time: 25h
Theory classes: 10h
Self study : 15h

Electroacoustic resonators

Description:
The topics covered in this section are:
• Types of resonators
• Manufacturing technologies
• Circuit models of electroacoustic resonators
• Undesired effects limiting performance
• Characterization and measurement of electroacoustic resonator

Full-or-part-time: 35h
Theory classes: 15h
Self study : 20h

Electroacoustic filters

Description:
The topics covered in this section are:
• Basic principles of RF filter synthesis
• Characteristic topologies
• Synthesis of electroacoustic filters
• Design of electroacoustic filters
• Manufacturing processes

Specific objectives:

Full-or-part-time: 40h
Theory classes: 20h
Self study : 20h

Electro-acoustic sensors

Description:
The topics covered in this section are:
• Basic principles of gravimetric sensors
• Interrogation systems
• Applications

Full-or-part-time: 13h
Theory classes: 6h
Self study : 7h

ACTIVITIES

Classroom activities

Description:
These activities will be completed and reviewed in the classroom, interspersed with the professor's lectures. These are small problems that will help understand the professor's explanations. Some of these problems will be solved in groups, others individually. Specific objectives:
• Apply the concepts presented in class by actively involving the student.
• Resolve doubts about the concepts discussed.
• Monitor the student's level of understanding.

Material:
Problem statements provided by the professor.

Full-or-part-time: 14h
Self study: 8h
Theory classes: 6h

Introduction to RF circuit CAD Description

Description:
Introduction to design and characterization software for RF circuits and devices.

Full-or-part-time: 4h
Self study: 2h
Theory classes: 2h

Resonators design

Description:
Design of the dimensions of electroacoustic resonators for a given frequency and impedance

Full-or-part-time: 4h
Self study: 2h
Theory classes: 2h

Filter synthesis

Description:
Synthesis of several filter responses for a given set of specifications using the ladder configuration

Full-or-part-time: 4h
Theory classes: 2h
Self study: 2h

Filter simulation

Description:
Circuit design of the synthesized filter in previous lab session following the designing rules set in theory classes

Full-or-part-time: 8h
Theory classes: 4h
Self study: 4h

project: syntheis and design of a electro-acoustic multiplexer

Description:
Full synthesis and desing of a full multiplexer based on ladder configuration of the individual filters

Full-or-part-time: 27h
Theory classes: 11h
Self study: 16h

GRADING SYSTEM

Detail at infoweb of the course

EXAMINATION RULES.

The use of mobile phones is prohibited in all assessment tests.

BIBLIOGRAPHY

Basic:
- Pozar, David M. . Microwave engineering .
- Hashimoto, Ken-Ya. RF bulk acoustic wave filters for communications . Boston ; London : Artech House, cop. 2009. ISBN 978-1596933217.

Complementary:
- Hashimoto,Ken-Ya. Surface acoustic wave devices in telecommunications. Modelling and simulation. 2013. ISBN 978-3-540-67232-6.