UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Course guide
230472 - TCIRC - Circuit Theory

Unit in charge:	Barcelona School of Telecommunications Engineering
Teaching unit:	710 - EEL - Department of Electronic Engineering.

Degree:	BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Compulsory subject).

Academic year: 2023   **ECTS Credits:** 6.0   **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer:	Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura
Others:	Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Understanding the physics of semiconductors. Knowledge of microelectronic devices and their applications in nanotechnology, biophysics, photonics and communications. Ability to analyze the performance of electronic devices and integrated circuits.

Generical:
5. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

1. ABILITY TO CONCEIVE, DESIGN, IMPLEMENT, AND OPERATE COMPLEX PHYSICAL ENGINEERING SYSTEMS.
Ability to conceive, design, implement, and operate complex systems in the fields of micro and nano technology, electronics, advanced materials, photonics, biotechnology, and space and nuclear sciences.

Transversal:
2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 3. Taking social, economic and environmental factors into account in the application of solutions. Undertaking projects that tie in with human development and sustainability.
4. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
3. 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.

TEACHING METHODOLOGY

There will be three theoretical and two practical weekly sessions. The theoretical lectures will be devoted to a careful presentation of the basic concepts and the main results which will be illustrated with some examples. The practical sessions will be devoted to the solution of a variety of exercises and problems.

LEARNING OBJECTIVES OF THE SUBJECT

The student will learn how to analyze and design electronic circuits using equivalent models.

The student will use techniques in the time and frequency domain to analyze and design
circuits and will know the relationship between them.
After this course the student:
· Is able to use techniques in the Laplace domain to simplify the analysis of complex circuits.
· Is able to determine the transfer function of a circuit and knows the responses associated with that function
· Is able to analyze the stability of a circuit.
· Is able to represent graphically filters.

STUDY LOAD

Type	Hours	Percentage
Self study	85,0	56.67
Hours large group	65,0	43.33

Total learning time: 150 h

CONTENTS

1. Fundamentals of circuit theory

Description:
1.1. Fields theory versus circuits theory
1.2. Concept of a Bipole.
1.3. Circuit variables: voltage and current. Power.
1.4. Ideal circuit elements.
1.5. The circuit as a model. Examples of modeling physical systems.
1.6. Definition of the analysis problem.

Full-or-part-time: 11h
Theory classes: 3h
Practical classes: 2h
Self study : 6h

2. Elemental analysis of circuits

Description:
2.1. Network equations. Kirchoff laws.
2.2. Elemental analysis of linear circuits. Concept of equivalent bipole.
2.3. Series and parallel connections. Superfluous elements. Current and voltage dividers.
2.4. Real sources modelling. Equivalence between Thevenin and Norton forms.
2.5. Principle of superposition.
2.6. Elemental analysis of circuits with nonlinear loads.
2.7. Elemental analysis of circuits with active devices.
2.7.1. Elemental analysis of circuits with controlled sources.
2.7.2. The amplifier: gain power. Need for polarization. Concept of small signal.
2.7.3. The operational amplifier.
2.7.3.1. Modes: linear, saturation.
2.7.3.2. Validity of Models
2.7.4. Elemental analysis of linear and nonlinear circuits
2.8. The bipolar transistor: Symbol. Modes of operation. Linearized small-signal model.
2.9. The CMOS transistor: Symbol. Modes of operation. Linearized small-signal model.

Full-or-part-time: 47h
Theory classes: 12h
Practical classes: 8h
Self study : 27h

3. Laplace transformed circuit.

Description:
3.1. Classical method versus transformed method.
3.2. Fundamental properties of the Laplace transform.
3.3. Transformed circuit.
3.3.1. Transformation of variables, elements and interconnection laws.
3.3.2. Treatment of initial conditions.
3.3.3. Concepts of impedance and admittance.

Full-or-part-time: 33h
Theory classes: 9h
Practical classes: 6h
Self study : 18h

4. Study of linear dynamical circuits

Description:
4.1. Temporal response of linear circuits.
4.1.1. Response components: zero-input, zero-state response.
4.2. Network function concept.
4.2.1. Definition and types. Properties.
4.2.2. Forms of free response associated with poles.
4.3. Initial impulse response. Convolution.
4.4. Stability.
4.5. State variables.

Full-or-part-time: 36h
Theory classes: 9h
Practical classes: 6h
Self study : 21h

5. Frequency response of linear circuits.

Description:
5.1. The circuit as a signal processor in the frequency domain.
5.1.1. Networks in sinusoidal steady-state analysis. Amplification and drift.
5.1.2. Representation of signals in the frequency domain.
5.1.3. Fourier series and Fourier transform.
5.2. Phasorial equivalent circuit.
5.3. Graphical representation of the frequency response. Amplification and phase curves. Calculation from the poles and zeros diagram.
5.4. Bode diagrams. Asymptotes and corrections.

Full-or-part-time: 23h
Theory classes: 6h
Practical classes: 2h
Guided activities: 3h
Self study : 12h

GRADING SYSTEM

There will be a final exam (EF) and a partial exam (EP).
The final score will follow from max{EF, 0.7*EF+0.3*EP}

BIBLIOGRAPHY

Basic:
- Thomas, R.E.; Rosa, A.J.; Toussaint, G.J. The analysis and design of linear circuits. 7th ed. John Wiley & Sons, 2012. ISBN 9781118065587.