Course Unit	Circuits II			Field of study	Physics		
Bachelor in	Electrical and Computers Engineering			School	School of Technology and Management		
Academic Year	2023/2024	Year of study	1	Level	1-1	ECTS credits	6.0
Type	Semestral	Semester	2	Code	9112-742-1202-00-23		

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			15	15	30	-	-	-	-	-

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s)	Fernando Jorge Coutinho Monteiro, Ana Flavia Peixoto de Camargos, Luís Manuel Montenegro de Araújo Pizarro

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Perform sinusoidal steady-state circuit analysis using the Steinmetz transform.
2. Analyse the steady-state response of the different passive elements.
3. Determine the active, reactive and apparent powers.
4. Analyse series and parallel RLC circuits and resonance phenomena.
5. Understand the advantages of three-phase systems compared to single-phase systems.
6. Analyse and size power factor compensation systems in symmetrical and balanced single-phase and three-phase systems.

Prerequisites

Before the course unit the learner is expected to be able to:
Matrices and complex arithmetic. Derivatives and integrals of elementary functions.

Course contents

Energy storage elements. Sinusoidal waveforms and Steinmetz transform. Sinusoidal steady-state analysis using phasors. AC steady-state power. Resonant circuits. Balanced three-phase circuits. Solution of the first and second-order differential equations. The natural and forced responses of RL, RC and RLC circuits.

Course contents (extended version)

1. Energy storage elements.
   - Capacitors. Capacitance. Energy storage in a capacitor. Series and parallel capacitors.
   - Inductors. Inductance. Energy storage in an inductor. Series and parallel inductors.
2. Sinusoidal steady-state analysis.
   - Sinusoidal signals, Steinmetz transform and phasors.
   - Phasor relationships for resistances, inductances and capacitors.
   - Impedance and admittance.
   - Kirchhoff's laws using phasors.
   - Node voltage and mesh current analysis using phasors.
   - Superposition, Thévenin and Norton equivalents, and source transformations.
3. AC steady-state power.
   - Instantaneous power and average power.
   - Active, reactive, apparent and complex powers.
   - Power factor and compensation principles.
   - Maximum power transfer.
   - Resonant circuits.
4. Balanced three-phase systems.
   - Phase to phase and neutral to phase voltages.
   - Star and delta connections.
   - Power, power factors and power factor compensation in three-phase systems.
   - Single-phase analysis.
5. Natural and forced responses of RL, RC and RLC circuits.
   - Differential equations for first-order circuits.
   - Response of a first order circuit to a constant input and to a nonconstant input.
   - Differential equations for second-order circuits.
   - Natural response and forced response of second order circuits.

Recommended reading

1. R. C. Dorf and J. A. Svoboda, Introduction to Electric Circuits, 9th ed. , John Wiley & Sons, Inc. , 2013.
2. J. W. Nilsson and S. A. Riedel, Electric Circuits, 11th ed. , Pearson, Prentice Hall, 2019.
3. W. H. Hayt, J. Kemmerly and S. M. Durbin, Engineering Circuit Analysis, 8th ed. , McGraw-Hill International Editions, 2011.
4. V. Meireles, Circuitos Eléctricos, 5. ª ed. , Edições LIDEL, 2009.
5. T. L. Floyd, D. M. Buchla, Principles of Electric Circuits: Conventional Current, 10th ed. , Pearson Education Limited, 2021.

Teaching and learning methods

Theoretical classes: presentation of the course contents. Practical and laboratory classes: problem-solving to support the expected learning outcomes and laboratory experiments to realize in practice some issues treated analytically.

Assessment methods

- Distributed Assessment - (Regular, Student Worker) (Final, Supplementary, Special)
   - Laboratory Work - 40%
   - Final Written Exam - 60%

Language of instruction

Portuguese, with additional English support for foreign students.

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Electronic validation

Fernando Jorge Coutinho Monteiro	José Augusto de Almeida Pinheiro Carvalho	José Luís Sousa de Magalhaes Lima	José Carlos Rufino Amaro
15-02-2024	17-02-2024	27-02-2024	02-03-2024

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