ECTS CATALOGUE

The main language of instruction at Coimbra Institute of Engineering is Portuguese. However, some courses from degree and master programs can be offered in English and/or with a tutorial support in English.

The ECTS catalogue includes subject contents in English Language. The Students can choose subjects from this Catalogue to the study plan proposal (Learning Agreement) to be analyzed carefully by the Departmental Coordinators and to be adjusted, after student's arrival, if necessary.

This ECTS catalogue contains information that is valid for this academic year. ISEC reserves the right to adjust the courses offered during the academic year and is not responsible for typing errors or printing mistakes.

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Polytechnic Institute of Coimbra (P COIMBRA 02) - Coimbra Institute of Engineering - ISEC

Electrical Engineering Department - **Electrical Engineering Bachelor**

# Electrical Engineering Bachelor

| Old Code | New Code | Title - Portuguese | Title - English | ECTS | Term |
|---|---|---|---|---|---|
| | | **1.º ano / 1st Year** | | | |
| | 60021872 | Análise Matemática I | Calculus I | 6 | Autumn |
| | 60021894 | Álgebra Linear | Linear Algebra | 5 | Autumn |
| 910903 | 60021918 | Física Geral | General Physics | 4,5 | Autumn |
| 910904 | 60021935 | Introdução à Programação | Introduction to Programming | 5 | Autumn |
| 910905 | 61001012 | Eletrotecnia I | Electrical Circuit Theory I | 5,5 | Autumn |
| 910906 | 60021971 | Aplicacionais para a Engenharia | Software Tools for Engineering | 4 | Autumn |
| 910907 | 60021993 | Análise Matemática II | Calculus II | 5 | Spring |
| 910908 | 61000709 | Matemática Aplicada à Eletrotecnia | Mathematics Applied to Electrical Engineering | 4,5 | Spring |
| 910909 | 60022033 | Sistemas Digitais | Digital Electronic Systems | 5 | Spring |
| 910910 | 60022056 | Programação de Computadores | Computer Programming | 5,5 | Spring |
| 910911 | 61001023 | Eletrotecnia II | Electrical Circuit Theory II | 5 | Spring |
| 910912 | 60022095 | Medidas e Instrumentação | Instrumentation and Measurement | 5 | Spring |
| | | **2.º ano / 2nd Year** | | | |
| 910917 | 60022196 | Teoria dos Sistemas | Theory of Systems | 6,5 | Autumn |
| 910915 | 60022157 | Introdução aos Sistemas de Comunicação | Introduction to Communication Systems | 6,5 | Autumn |
| 910914 | 61000653 | Eletromagnetismo | Electromagnetism | 5,5 | Autumn |
| 910913 | 60022110 | Probabilidades e Estatística | Probability and Statistics | 5 | Autumn |
| 910916 | 60022179 | Microprocessadores * | Microprocessors * | 6,5 | Autumn |
| 910920 | 61000664 | Eletrónica | Electronics I | 6,5 | Spring |
| 910919 | 61000791 | Sistemas de Energia Elétrica | Electrical Power Systems | 5,5 | Spring |
| 910918 | 61000681 | Instalações Elétricas** | Electrical Installations I ** | 5,5 | Spring |
| 910922 | 61000692 | Máquinas Elétricas | Electrical Machines I | 6,5 | Spring |
| 910921 | 60022275 | Automação Industrial e Robótica | Industrial Automation and Robotics | 6 | Spring |
| | | **3.º ano / 3rd Year - Ramo de Sistemas de Energia / Specialization in Power Systems** | | | |
| 910923 | 61000763 | Projeto de Instalações Elétricas ** | Design of Electrical Installations** | 6 | Autumn |
| 910924 | 61001001 | Eletrónica de Potência | Power Electronics | 6 | Autumn |
| 910925 | 61000647 | Complementos de Máquinas Elétricas | Electrical Machines II | 6 | Autumn |
| 910926 | 61000726 | Produção de Energia Elétrica | Electrical Power Generation | 6 | Autumn |
| 910927 | 61000625 | Análise de Sistemas Elétricos | Power Systems Analysis | 6 | Autumn |
| 910928 | 61000715 | Organização e Gestão de Empresas | Business Planning and Management | 5,5 | Spring |
| 910929 | 61000670 | Gestão de Energia | Energy Management | 6 | Spring |
| 910930 | 61000774 | Qualidade de Serviço em Sistemas de Energia Elétrica | Electric Power Systems Quality | 5,5 | Spring |
| 910931 | 61000619 | Acionamentos Eletromecânicos *** | Electromechanical Drives*** | 6 | Spring |
| 910932 | 61000752 | Projeto de Sistemas de Energia Elétrica | Electrical Power Systems Project | 7 | Spring |
| | | **3.º ano / 3rd Year - Ramo de Automação / Specialization in Automation** | | | |
| 910955 | 61000763 | Projeto de Instalações Elétricas** | Electrical Installations II ** | 6 | Autumn |
| 910956 | 61001001 | Eletrónica de Potência | Power Electronics | 6 | Autumn |
| 910957 | 61000636 | Complementos de Eletrónica | Electronics II | 6 | Autumn |
| 910958 | 61000647 | Complementos de Máquinas Elétricas | Electrical Machines II | 6 | Autumn |
| 910959 | 60022546 | Controlo de Sistemas *** | Systems Control *** | 6 | Autumn |
| 910960 | 61000715 | Organização e Gestão de Empresas | Business Planning and Management | 5,5 | Spring |
| 910961 | 61000670 | Gestão de Energia | Energy Management | 6 | Spring |
| 910962 | 61000780 | Redes Locais e Industriais | Local and Industrial Networks | 6 | Spring |
| 910963 | 60022619 | Manutenção e Controlo de Qualidade | Maintenance and Quality Control | 5,5 | Spring |
| 910964 | 61000737 | Projeto de Automação | Automation Project | 7 | Spring |
| | | **3.º ano / 3rd Year - Ramo de Eletrónica e Telecomunicações / Specialization in Electronics and Telecommunications** | | | |
| 910988 | 61000763 | Projeto de Instalações Elétricas** | Electrical Installations Design ** | 6 | Autumn |
| 910989 | 61001001 | Eletrónica de Potência | Power Electronics | 6 | Autumn |
| 910990 | 61000636 | Complementos de Eletrónica | Electronics II | 6 | Autumn |
| 910991 | 60022692 | Processamento de Sinal | Signal Processing | 6 | Autumn |
| 910992 | 60022715 | Comunicação Analógica e Digital | Analog and Digital Communication | 6 | Autumn |
| 910993 | 60022748 | Sistemas de Telecomunicações | Telecommunication Systems | 6 | Spring |
| 910994 | 61000780 | Redes Locais e Industriais | Local and Industrial Networks | 6 | Spring |
| 910995 | 60022780 | Propagação e antenas | Propagation and Antennas | 5,5 | Spring |
| 910996 | 61000748 | Projeto de Eletrónica e Telecomunicações | Electronics and Telecommunications Project | 7 | Spring |
| 910992 | 61000715 | Organização e Gestão de Empresas | Business Planning and Management | 5,5 | Spring |

*** Requires knowledge on C – Programing Language**

**** These subjects are related to Portuguese Legislation. Not recommended for all nationality's students (exceptions: Spain, Italy)**

***** This subject is taught just in Portuguese Language**

| | | | |
|---|---|---|---|
| **Subject Title:** | Analog and Digital Communication | **Código:** | 60022715 |
| **Language:** | Portuguese | **ECTS:** | 6 |
| **Cicle:** | 1st Cicle | **Teaching method:** | Presencial |
| **Academic Year:** | 2020/2021 | | |
| | | **Total of working hours:** | 156 |

Objective
To acquire knowledge in analogue and digital communications used in nowadays systems. Moreover students must understand, analyse (and implement if applicable) analogue and digital modulation techniques; line codes and multiple access techniques. Generic skills: Ability to analyse and synthesize; ability to develop independent work and work in teams, ability to apply technical knowledge to solve specific problems in the area of communication systems, ability to communicate verbally and written in Portuguese. Specific Skills: Know and understand nowadays analogue and digital communication systems; understand, analyse and implement systems based on analogue modulation techniques, understand, analyse and implement systems based on digital modulation techniques, know and understand the main line codes; understand and perform power balance in communication systems.

Program Contents
1. Introduction: motivation; historical perspective and social impact of communications. 2. Signal Analysis: signals and spectrum; Fourier transform; LTI systems, filters; energy and power. 3. Analog Communications: amplitude modulation; DSB-AM; DSB-SC; SSB and VSB modulation. Angle modulation: Frequency Modulation (FM); Phase Modulation (PM); spectral analysis; FM generation and demodulation. 4. Digital Communications: Digital baseband modulation: NRZ, RZ, bipolar AMI, Manchester biphasic; adapted filters and correlators, ISI intersymbol interference; Digital modulation: linear binary modulations non binary; nonlinear digital modulations: binary modulation; non binary, error probabilities, modulated signals power spectrum. 5. Multiple Access Techniques: FDMA, TDMA, CDMA, OFDM and SDMA 6. Nowadays Communication Systems: radio and TV broadcasting systems; GSM and UMTS; DVBT; wireless networks WPAN, WLAN and WMAN and GPS radio navigation system.

Working hours
Theoretical: 30
Theoretical - Practical: 30

Teaching Method:
The lectures are essentially expository. In laboratory classes is privileged direct contact with real scenarios and existing technologies. Students must perform in groups, a broad set of measurements and simulations covering the following topics: 1) analogue amplitude modulation techniques, 2) analogue angle modulation techniques and 3) digital modulation techniques. Two Theoretical-practice classes are reserved for exercises resolution.

The curricular unit aims to provide training in the analogue and digital communications area. For this purpose in Chapter 2 presents the basic mathematical concepts to the understanding of both analogue and digital modulation techniques. Chapter 3 addresses different analogue modulation techniques giving students the ability to measure and analyse systems using analogue modulation

techniques: amplitude and phase. Similarly, chapter 4 gives students the ability to analyse a system based on a digital modulation technique. In chapter 5, the multiple access techniques used in current communication systems are presented. Chapter 6 covers a variety of communication systems and current technologies that exemplify the earlier presented concepts.

The expositive teaching methodology used in lectures allows students to acquire the knowledge transmitted by the teacher. Laboratory experiences promote teamwork and develop the soft-skills such us: reports writing, independent research, selection of information and communication during the oral defence, since student has to justify the selected choices. In class reserved for solving practical exercises, the teacher presents the basic fundamentals that point to the practical problem resolution by encouraging students to find valid solutions and among them select the best possible solution (if applicable).

| | | | |
|---|---|---|---|
| **Subject Title:** | Introduction to Communication Systems | **Código:** | 60022157 |
| **Language:** | Portuguese | **ECTS:** | 6.5 |
| **Cicle:** | 1st Cicle | **Teaching method:** | Presencial |
| **Academic Year:** | 2020/2021 | | |
| | | **Total of working hours:** | 169 |

Objective:
To understand the fundamentals of communication systems and to develop the ability to calculate and analyse simple analog and digital communication systems, without and with noise analysis. Special attention is given to the ITED Project. Skills - To understand: the information concept and the representation of information by means of electrical signals; the signal representation in time and frequency; the representation of linear systems by the transfer function; the nature, representation and effects of noise and interference; the limitations of physical channels to the transmission of information signals; (and to know) the baseband transmission techniques including examples of interfaces; the principles and the motivations to use modulation; (and to know) the more representative analog and digital modulation techniques; the principles of light and radio propagation applied to fiber optics and radio communications; the advantages and principles of communication networks.

Program Contents
The information concept Signals and noise representation; Power signals and Fourier Series Energy signals and Fourier Transform Transfer function representation of systems Introduction and examples of filters Linear and nonlinear distortion Physical transmission media- twisted pair, coaxial cable, optical fiber and radio Limitations of physical media Channel bandwidth and capacity Baseband transmission Analog modulation techniques Digital modulation techniques Fundamentals of radio propagation Power budget and applications Characterization of thermal noise and Signal-to-Noise Ration

Working hours
Practical and Laboratorial:30
Theoretical: 30
Theoretical - Practical: 15

Teaching Method:
world problems and systems. Interactive solving of mixed theory-practice exercises in the Tutorial Guidance classes, with moderated teacher intervention. Laboratory experiments in the Practical-Laboratory classes, organized in groups of 2 students with a final per-work, per-group report and an individual assessment. Attendance is mandatory in these classes (2 absences maximum). The ECTS organization considers 96 semester hours for autonomous student work. Evaluation: final written exam: 14 points (70%) - minimum 6. Laboratory experiments, associated reports and individual assessment: 6 points (30%) - minimum 4. From the 14 exam points, 2 can be obtained from 2 short exams proposed during the semester in the lectures. For the students with Student Worker status, and for the components with mandatory attendance and distributed evaluation, adjusts to the defined rules are possible.

The elements required to understand the fundamentals of communication systems and to develop the ability to calculate and analyze simple communications, are progressively presented. The information concept and the information representation by means of electrical signals is studied, followed by the application of the mathematical tools required to represent the signals in the frequency domain, fundamental in information transmission problems. The transfer function of linear systems is studied, allowing a simple analysis of signals through physical channels. The main characteristics and limitations of the physical communication media are presented, as well as the more representative baseband and modulation transmission techniques. A model for power budget calculations is proposed and applied, which includes a thermal noise characterization. Application exercises without and with noise are carried out, focusing in applications to Telecommunication Infrastructures in Buildings.

To guarantee the learning outcomes and competence acquisition, all topics are coherently integrated in the different classes and autonomous study time. Special focus is put on the interconnection between the concepts and examples presented in the Lectures, the exercises to be solved in the Tutorial Guidance classes and the experimental work to be implemented in the Practical Laboratory classes. The sequence is carefully prepared, including practical examples in the Lectures in the format that is used in the remaining classes and including a synthesis of the theoretical concepts needed in a given exercise or laboratory experiment. This is done using the same formal representations and notation, supported by common bibliography that allows a uniform view of the concept to be studied. Real systems examples are given, whenever relevant. The topics in the Syllabus, presented in the Lectures, are deepened and consolidated in the Tutorial Guidance and Practical-Laboratory classes through the partially assisted solving of the following Exercise Papers: Signal Classification Phasor representation and Fourier Series Energy signals and Fourier Transform Transfer Function and Filters Power budget and noiseless analog communication Introduction to thermal noise, Noise Figure and Equivalent Noise Temperature In the Practical-Laboratory classes, the students implement simulation and hardware experiments, integrating several studied topics and demonstrating their validity and applicability. These experiments are prepared and implemented by teams of two students and with a high degree of autonomy. The implemented laboratory experiments are the following: Introduction to Matlab for signal processing Decomposition and Syntheses of periodic signals using Fourier Series Simulation and experimental determination of the transfer function of a filter Analog communication without noise Analog communication with thermal noise Design and test of an antenna for the WiFi band The non-contact study time reserved for this subject shall be used to the study of the theoretical concepts, the resolution of additional exercises and for the preparation of the laboratory experiments and associated reports.

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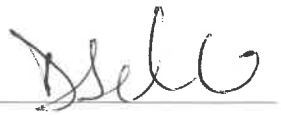
Signature of Teacher: 

**Licenciatura em Engenharia Eletrotécnica**

**BsC Electrical Engineering**

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** ENERGY MANAGEMENT

**Specialization (s)** AUTOMATION/POWER SYSTEMS

**Subject type** Engineering Sciences **Research Area** Electrical Engineering

**Year** 3rd **Semester** 2nd **ECTS** 6

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 156 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 52 |
| Works / Group Works | 30 |
| Project | 15 |
| Evaluation | 3 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Dulce Helena de Carvalho Coelho | PhD. | Prof. Adjunta |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratoty Lectures | Dulce Helena de Carvalho Coelho | Doutoramento | Prof. Adjunta |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Dulce Helena de Carvalho Coelho

**Goals**

The main aims of this course unit are:

To familiarize students with the basic concepts of energy management;

To know the tariff legislation; To learn the methodology, phases and expected outputs of energy audits;

To help students to develop the knowledge and analytical skills needed for a successful career in the energy sector, in terms of energy policy analysis and energy management

**Skills**

At the end of this course unit the learner is expected to be able:

To become familiar with the concepts related to energy use and efficient use of energy; To analyze electricity bills; To know how to prepare and perform energy audits; To know to apply energy consumption rationalization plans; To investigate and choose efficient technological solutions and be able to argue with the employer or client

Signature of Teacher:

**Program Contents**

Introduction to Energy Management.
Importance of various sectors of the economy in the global energy consumption.
Energy rate structures. The Portuguese fees. Electric bill analysis
Demand-Side Management (DSM): Concepts; DSM Planning and Implementation; Costs and benefits of DSM.
Energy Audits: Methodology and equipment; Energy Audit results. Methods for estimating energy savings. Economic analysis. Energy Consumption Rationalization Plans. Rational Use of Energy (RUE) by sectors of activity (industry, buildings and transport). Reduction of electricity consumption: Lighting; Driving force; Other equipment; Solutions for energy recovery.
Portuguese legislation about energy efficiency. The Management System of Intensive Energy Consumption (SGCIE). ).
Energy Consumption Rationalization Plan (PREn). PREn Report structure.

**Bibliography**

Manual of Practice for Energy Efficiency (in Portuguese), BCSD Portugal/ ISR Coimbra, 2005,
EU and Portuguese Legislation.
Dulce Coelho. Energy Audits (in Portuguese), 2000, ISEC 1-9-20
Dulce Coelho, Demand-Side Management – Impacts on Production Planning, 1998. ISEC 1-9-21
Dulce Coelho. Energy Efficiency in Motor drive Systems (in Portuguese), ISEC 2005
Several Reports of Energy Audits
http://www.adene.pt
http://www.edp.pt
http://www.dgeg.pt
http://www.erse.pt

**Access Conditions and Attendance Excuse**

**Conditions for Exam Admission**

**Evaluation Method**

Final written exam

**Conditions for Results Improvement**

According to the legislation

| **Date** | **Signature from the lecturer responsible for the course** |
|---|---|
| **14/01/2019** | Dulce Helena Coelho |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

**Licenciatura – BsC Engenharia Electrotécnica** (Português)

**Licenciatura – BsC Electrotechnical Engineering** (Inglês)

Academic Year: 2018/2019

## Program Contents

**Course Unit** BUSINESS PLANNING AND MANAGEMENT

**Specialization (s)** --- **Research Area** Engineering and Industrial Management

**Subject type**

**Year** 3rd **Semester** 2nd **ECTS** 5,5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 2 | 28 |
| Practical-Laboratoty Lectures | | |
| Tutorial Orientation | | |
| Project | | |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 64 |
| Works / Group Works | |
| Project | |
| Evaluation | |
| Additional | |

**Total of Working Hours** 120

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Alexandre Miguel d'Orey de Gouveia e Melo | MSc | Adj.Professor |
| Theoretical-Pratical Lectures | Alexandre Miguel d'Orey de Gouveia e Melo | MSC | Adj. Professor |

**Responsible(s) Lecturer (s)** Alexandre Miguel d'Orey de Gouveia e Melo

**Goals**

The objectives are to understand the basic principles of organization and management of companies and organizations, from the strategic level to the operational level in the multiple aspects, creating a common domain of knowledge between engineers and managers.

**Skills**

At the end of this course students should be able to:
Understand the influence of economic, social, technological and political environments on organizations and their managers.
Understand the importance of competitiveness and business ethics and use tools and know-how that allow management to be carried out in the context of the company culture and in a business perspective that is open to innovation and change.
Identify the different planning horizons of the operations and the procedures to be applied in each case.
Anticipate needs, plan and scale resources, ensuring compliance with goals and optimizing operations.
Apply project planning and control techniques.
Know the different philosophies of production management.
Generally, the aim is to develop problem-solving skills by applying the knowledge acquired

Signature of Teacher:_____

**Program Contents**

Organization and Management
Organizations and companies - The Management function;
Organizations and the environment, planning and product lifecycle.
The financial statements in the scope of business management.
Fundamentals for analysis and management of companies, economic and financial indicators and fundamental management ratios.
Financial analysis and economic viability of investments and projects.
Project management using CPM and PERT techniques.

**Bibliography**

LISBOA, J. [et al.] , (2004), "Introdução à Gestão das Organizações", editora Vida Económica,
ROBBINS, Stephen P.; COULTER, Mary, "Management", Prentice-Hall, 6th ed. [658 ROB]
SEBASTIÃO TEIXEIRA, (1998),"Gestão das Organizações", Alfragide ,McGraw-Hill
MARQUES PINTO, C.A. [et.al.] (2009)."Fundamentos de Gestão", 2ª Ed.Lisboa, Editorial Presença

**Access Conditions and Attendance Excuse**

According to the regulatory terms.

**Conditions for Exam Admission**

All students regularly enrolled in this UC.

**Evaluation Method**

Assessment by Written Exam.

**Conditions for Results Improvement**

By exam, according to the regulatory terms.

**Date**

**21st January 2019**

**Signature from the lecturer responsible for the course**

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

**Licenciatura – BsC Engenharia Eletrotécnica - 9109**

**Licenciatura – BsC Electrical Engineering - 9109**

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** ELECTRICAL POWER SYSTEMS PROJECT

**Specialization (s)** Power Systems

**Subject type** Specialty Sciences **Research Area** Electrical Engineering

**Year** 3rd **Semester** 2nd **ECTS** 7

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | | |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | | |
| Tutorial Orientation | 2 | 28 |
| Project | 2 | 28 |
| **Total of Working Hours** | | **182** |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | |
| Works / Group Works | |
| Project | 124 |
| Evaluation | 2 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | | | |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratoty Lectures | | | |
| Tutorial Orientation | Adelino Jorge Coelho Pereira | PhD | Adjunct Professor |
| | Carlos Manuel Borralho Machado Ferreira | PhD | Coordinator Professor |
| | Cristina Isabel F. Figueiras Faustino Agreira | PhD | Adjunct Professor |
| | Dulce Helena Carvalho Coelho | PhD | Adjunct Professor |
| | Manuel Maria Abranches Travassos Valdez | PhD | Adjunct Professor |
| | Paulo Filipe de Almeida Ferreira Tavares | PhD | Adjunct Professor |
| | Rita Manuela Fonseca Monteiro Pereira | PhD | Adjunct Professor |
| Project | Adelino Jorge Coelho Pereira | PhD | Adjunct Professor |
| | Carlos Manuel Borralho Machado Ferreira | PhD | Coordinator Professor |
| | Cristina Isabel F. Figueiras Faustino Agreira | PhD | Adjunct Professor |
| | Dulce Helena Carvalho Coelho | PhD | Adjunct Professor |
| | Manuel Maria Abranches Travassos Valdez | PhD | Adjunct Professor |
| | Paulo Filipe de Almeida Ferreira Tavares | PhD | Adjunct Professor |
| | Rita Manuela Fonseca Monteiro Pereira | PhD | Adjunct Professor |

**Responsible(s) Lecturer (s)** Carlos Manuel Borralho Machado Ferreira

**Goals**

The purpose of the Electric Power Systems Project is to involve students in a project team, aiming to develop and test a system with a specific function, using concepts and technologies in the field of Electric Power Systems.
Upon completing this course students should demonstrate autonomy in identifying and analyzing problems and in the proposal, implementation and testing of specific solutions.
The project typically includes hardware, software, a demonstration test, the preparation of a detailed report, a public presentation and, when appropriate, a scientific publication.

Signature of Teacher:

**Skills**
At the end of this course unit the learner is expected to be able:
Ability to select technical solutions in the field of Electric Power Systems
Ability to design and conduct experiments and to analyse and interpret data
Ability to identify, formulate and solve engineering problems
Ability to communicate in a professional and technical manner, both in written and oral form, the subjects related to this course
Ability to discuss and argue in favor of the proposed technical solutions with team leaders, employers and clients
Design, implement, test and maintain the proposed solutions
Ability to work effectively with others on a common task

**Program Contents**

The study plan is specific of each project, however all comprise the following steps:
Analysis of requirements for each project;
Bibliographic search in books, papers, data sheets and application notes;
Analysis of different options to solve each individual problem;
Design of the system and definition of procedures for testing and validation;
Implementation of a prototype for the proposed system;
Tests and validation of the implemented system;
Implementation of the final solution;
Documentation of all phases of the project;
Carry out monitoring and project management;
Preparation of a final report.

**Bibliography**
Books, papers, reports and other documents depending on the characteristics of each project. Manuals and Application Notes specific to the hardware and software to use.
Each Instructor will give most important references for the project. Students are free and invited to complete and discuss all study material.

**Access Conditions and Attendance Excuse**
For students of special schemes, namely those under the worker-student statute it should be agreed upon between the course unit and the student, on the initiative of the latter and at the beginning of the academic semester, an alternative way of functioning of these components, when the student cannot effectively attend them at the scheduled times.

**Conditions for Exam Admission**
All students that have delivered the final Project within the established deadlines have access to the exam (oral test-presentation and defense of the project).

**Evaluation Method**
Project presentation, demonstration of a prototype and production of the final report.
Project work presentation and public defense before a jury of three elements.

Final Project Deadlines:
First Exam - delivery of the project until June 21, 2019 and assessment until June 28, 2019
Second Exam - delivery of the project until July 17, 2019 and assessment until July 24, 2019
Special Exam - delivery of the project until September 13, 2019 and assessment until September 18, 2019

**Conditions for Results Improvement**
In accordance with the regulation of the Instituto Superior de Engenharia de Coimbra.

| Date | Signature from the lecturer responsible for the course |
|---|---|
| 21/01/2019 | Carlos Machado Fernandes |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:

**Licenciatura – Engenharia Eletrotécnica - Diurno – 9109**

**BSc – Electrical Engineering**

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** ELECTROMECHANICAL DRIVES (ACIONAMENTOS ELETROMECÂNICOS)

**Specialization (s)** POWER SYSTEMS

**Subject type** Speciality Siciences **Research Area** Electrical Engineering

**Year** 3rd **Semester** 2nd **ECTS** 6

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 156 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 64 |
| Works / Group Works | 33 |
| Project | |
| Evaluation | 3 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Paulo José Gameiro Pereirinha | PhD | Prof. Coordenador |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratoty Lectures | Paulo José Gameiro Pereirinha | PhD | Prof. Coordenador |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Paulo José Gameiro Pereirinha

**Goals**

To give students theoretical, practical and experimental skills on electromechanical drives and on the respective protection, command and control devices.

**Skills**

At the end of this course unit, the student is expected to be able to use, design, analyze, optimize, protect and implement electromechanic drives, integrating three-phase induction motors, soft-starters, variable-speed drives, contactors, protection devices and mechanical transmission.
The learning outcomes, associated with those acquired in other course units, contribute for the understanding of the operation of electric motors and of the respective control equipment, the capability of design and implementation of command and protection systems of industrial equipment and the respective electric power networks, the knowledge of relevant aspects of industrial electric power networks and equipment maintenance, and the capability to define maintenance schemes for electromechanical equipment.

**Program Contents**

**1 - Introduction to electromechanical drives**

Energy conversion and electromechanical drives. Constant and variable speed electromechanical drives. Fundamental equation of dynamics. Inertia, friction and elastic effects. Types of loads. Mechanical transmissions and applications. Models and equivalent schemes of three-phase induction motor.

Signature of Teacher: _____

**2 - Speed control, torque and position**
Soft starters and variable frequency drives; Main functions; Scalar control ("V/f" and "E/F") and vector control. Speed and position transducers.

**3 - Design, analysis and optimization of motive power electrical systems**
Electromechanical drives efficiency and reliability. Equipment selection and sizing.
Contactors and relays. AC and DC feed coils. Contactor selection according to the application. Electromagnetic and thermal effects of short circuits. Coordination types. Solutions with 1, 2 or 3 devices for performing the basic functions of a motor output.
Standards and symbols for electrical diagrams.
Induction motor starting methods and associated control and power circuits.
Thermal behavior of electric motors. Operating temperature and lifetime. Operating range of electric motors and electronic variable speed drives. Oversizing and power quality impact in the performance of induction motors.
Induction motors and electronic variable speed drives standards. Insulation classes and motor mounting arrangements (positions). Motor duty cycles.
Potential for energy savings. International Efficiency classes. Turnaround time of investment. Different technological combinations.

**4 - special and Emerging Technologies**
Permanent magnet motors. Reluctance motors. Linear induction motors and reluctance.

NOTE: In order to ensure the coordination of measures between the theoretical and laboratory practice, the teaching sequence of the materials may not be exactly the shown above.

**Bibliography**
**Lessons presentations delivered by the instructors.**
**Problems and Laboratory Guide (in Portuguese), ISEC.**


- J. C. P. Palma, Accionamentos electromecânicos de velocidade variável, Fundação Calouste Gulbenkian, Lisboa, 1999.
- Groupe Schneider, Esquemateca: tecnologias do controlo industrial, Cergy-Pontoise, Editions Citef, 1994.
- Ion Boldea, Syed A. Nasar, Electric Drives, 3rd ed., CRC Press, Boca Raton, 2016.
- Jean Chatelain, Machines électriques - Tome I; Machines électriques - Tome II, Presses Polytechniques Romandes, 1983.
- Apontamentos do Professor Joaquim Carvalho para a disciplina de Complementos de Máquinas Eléctricas das licenciaturas bietápicas em Engenharia Electrotécnica e Engenharia Electromecânica.
- Joaquim Carvalho, Máquinas de Indução, ISEC, 2006.
- Cahier Technique Schneider Electric n° 208, Démarreurs et variateurs de vitesse électroniques, Nov. 2003.
- Helena Santos, Curso de formação PCP - Protecção e Comando de Potência, e DHM - Diálogo Homem Máquina, Schneider Electric Portugal.
- Instruções de Operação da SEW e Manuais SEW Drive Engineering.
- Catálogos de Fabricantes (Schneider Electric/Telemecanique, ABB, SEW, WEG,...).
- de Almeida; A. Gomes; C. Patrão; F. J. T. E. Ferreira; L. Marques; P. Fonseca; R. Behnke: "Manual Técnico de Gestão de Energia", Dep. de Eng. Electrotécnica e de Computadores, Universidade de Coimbra, ISBN 978-972-8822-10-1, 2007.
- ABB, Low voltage motors Motor guide, 3rd Ed., 2014. (https://new.abb.com/docs/librariesprovider53/about-downloads/low-voltage-motor-guide.pdf)


Complementary bibliography


- Stephen D. Umans, Máquinas Elétricas de Fitzgerald e Kingsley, 7 Ed., Artmed Editora, junho de 2014.
- Helena Santos, Apontamentos de Curso de Variação de Velocidade, Schneider Electric Portugal.
- Ferreira, Fernando J. T. E. and Anx00EDbal T. de Almeida. "Reducing Energy Costs in Electric-Motor-Driven Systems: Savings Through Output Power Reduction and Energy Regeneration." IEEE Industry Applications Magazine 24 (2018): 84-97.
- Patrick Brunet, Introduction à la commande vectorielle des machines asynchrones, LTEG Henri Brisson, Vierzon (disponível em http://geea.org.pagesperso-orange.fr/telechargement/Mas.pdf em jan 2019).
- Bimal K. Bose, Recent Advances and Applications of Power Electronics and Motor Drives, Tutorial in The 7th WSEAS International Conference on Electric Power Systems, High Voltages, Electric Machines, Venice, Italy, November 21-23, 2007.
- Rotary encoder, Wikipedia, the free encyclopedia, http://en.wikipedia.org/wiki/Rotary_encoder
- Gray code, Wikipedia, the free encyclopedia, http://en.wikipedia.org/wiki/Gray_code
- Curso CS-SYSD Variadores de Velocidade, OMROM YASKAWA Motion Control.
- Almeida, A.; Ferreira, F.; Fong, J.; Conrad, B.: "Electric Motor Ecodesign and Global Market Transformation", IEEE Industrial & Commercial Power Systems Conf., Conf. Proc., Florida, USA, May 4-8, 2008.
- De Almeida, A.; Ferreira, F.; Busch, J.; Angers, P.: "Comparative Analysis of IEEE 112-B and IEC 34-2 Efficiency Testing Standards Using Stray Load Losses in Low-Voltage Three-Phase, Cage Induction Motors", IEEE Transactions on Industry Applications, Vol. 38, No. 2, March/April 2002.
- de Almeida, A.; Ferreira, F. J. T. E.; Both, D.: "Technical and Economical Considerations to Improve the Penetration of Variable Speed Drives for Electric Motor Systems", IEEE Trans. on Industry Applications, Vol. 41, No. 1, pp. 188-199, Jan./Feb. 2005.

- Ferreira, F. J. T. E.; de Almeida, A.: "Method for In-Field Evaluation of the Stator Winding Connection of Three-Phase Induction Motors to Maximize Efficiency and Power Factor", IEEE Trans. on Energy Conversion, Vol. 21, No. 2, pp. 370-379, June 2006.
- Ferreira, F. J. T. E.; de Almeida, A.: "Novel Multiflux Level, Three-Phase, Squirrel-Cage Induction Motor for Efficiency and Power Factor Maximization", IEEE Trans. on Energy Conversion, Vol. 23, No. 1, pp. 101-109, March 2008.


**Access Conditions and Attendance Excuse**

For students of special schemes, namely those under the Worker-Student Statute, and for components with compulsory attendance and distributed assessment, it must be agreed between the responsible for the curricular unit and the student, on the initiative of the student and at the beginning of the academic semester, an alternative way of functioning of these components, when the student cannot effectively attend them at the scheduled times.

**Conditions for Exam Admission**

Approval in the practical / laboratory component, whose practical classes are of compulsory attendance (at least 80% of classes).
For students under the Worker-Student Statute, regarding the components with compulsory attendance and distributed assessment, it may be agreed between the person in charge of the unit curricular and the student, on his initiative, an alternative form of the functioning of these components.
In this case, during the first three teaching weeks, the students must indicate to their respective teacher, their status as student worker, establishing the form of practical work.
Authenticated working hours may be required by the employer.

**Evaluation Method**

Final exam, marked for 12 points (theoretical: 7 points; theoretical-practical: 5 points) and with a minimum of 5.0 points.
Practice / Laboratories: marked for 8 points, divided into 3 laboratory works. Minimum mark: 3.0 points.

In order to be approved in the Electromechanical Drives subject it is necessary to obtain a final minimum grade of 9.5 points (in 20 points) and a minimum grade in the final exam of 5.0 points (in 12 points).
Note: Students who do not obtain the minimum in the final exam will not be considered the laboratory grade, and the grade of the exam will be marked to 20 points.

**Conditions for Results Improvement**

Those set forth in Regulamento de Avaliação de Conhecimentos e Transição de Ano dos Estudantes das Licenciaturas of ISEC.

**Date**
**21/01/2019**

**Signature from the lecturer responsible for the course**

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

**Licenciatura – BSc Engenharia Eletrotécnica**
**9109**
**Licenciatura – BSc Electrical Engineering**

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** ELECTRIC POWER SYSTEMS QUALITY

**Specialization (s)** Power Systems

**Subject type** Specialty Sciences **Research Area** Electrical Engineering

**Year** 3rd **Semester** 2nd **ECTS** 5.5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 2 | 28 |
| Practical-Laboratoty Lectures | | |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 143 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 56 |
| Works/Group Works | 28 |
| Project | |
| Evaluation | 3 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Carlos Manuel Borralho Machado Ferreira | PhD | Prof. Coordenador |
| Theoretical-Practical Lectures | Carlos Manuel Borralho Machado Ferreira | PhD | Prof. Coordenador |
| Practical-Laboratoty Lectures | | | |
| Tutorial Orientation | | | |
| Project | | | |
| **Responsible(s) Lecturer (s)** | Carlos Manuel Borralho Machado Ferreira | | |

**Goals**

The main goals of this course unit are:
- To understand the causes and effects of power quality problems such as harmonic generation, losses due to harmonics, origin of single-time events such as voltage sags, voltage reductions, and outages;
- To understand the fundamentals of power quality issues and how to solve specific problems;
- To know how to perform power quality monitoring;
- To understand the Power Quality Standards;
- To evaluate the reliability of an electric power system.

**Skills**

At the end of this course unit the learner is expected to be able:
- To manage, design, implement and maintain electrical power systems;
- To understand how to function as part of a multidisciplinary team, both as a leader and team member;
- To design and conduct experiments and to analyze and interpret data;
- To identify, formulate and solve engineering problems;
- To communicate in a professional and technical manner, both in written and oral form, the subjects related to this course.

**Program Contents**

- Power Quality
  Definition of Power Quality, Power Quality Progression, Power Quality Terminology, Classification of power quality issues, Responsibilities of the Suppliers, and Users of Electrical Power, The Cost of Poor Power Quality;

- Electrical power quality problems
  Interruption, voltage sag and swell, undervoltage, overvoltage, voltage unbalance, waveform distortion, voltage fluctuation, power frequency variations, transient overvoltage;
- Sags and Interruptions
  Sources of Sags and Interruptions, Estimating Voltage Sag Performance, Fundamental Principles of Protection, Case Studies;
- Transient Overvoltages
  Sources of Transient Overvoltages, Principles of Overvoltage Protection, Devices for Overvoltage Protection, Case Studies;
- Long-Duration Voltage Variations
  Principles of Regulating the Voltage, Devices for Voltage Regulation, Utility Voltage Regulator Application, Capacitors for Voltage Regulation, Regulating Utility Voltage with Distributed Resources, Flicker, Case Studies,
- Harmonic Distortion
  Harmonic Distortion Evaluations, Harmonic Sources from Commercial Loads and from Industrial Loads, Locating Harmonic Sources, Effects of Harmonic Distortion, Interharmonics, Principles for Controlling Harmonics, Devices for Controlling Harmonic Distortion, Harmonic Filter Design, Case Studies, Standards of Harmonics;
- Power Quality Standards
- Power Acceptability Curves
- Power Quality Monitoring
  Power Quality Measuring Instruments and Equipment, Assessment of Power Quality Measurement Data, Power Quality Monitoring Standards, Case Studies;
- Power Quality Improvement
- Power Systems Reliability: Introduction, Reliability Functions, System Reliability Analysis, Time-based reliability Assessment, Markov Modelling for Reliability Analysis, Frequency and Duration Methods
- Team Work: 1. Quality of Service Indicators in Electrical Networks; 2. Power Quality Monitoring

**Bibliography**

Angelo Baggini, Handbook of Power Quality, Wiley-IEEE Press, 2008
EDP, Manual da Qualidade da Energia Elétrica, 2005
ERSE, Regulamento da Qualidade de Serviço e Manual de Procedimentos da Qualidade de Serviço, Regulamento n.º 3/2017
N. Kagan, E. J. Robba, H. P. Schmidt, Estimação de Indicadores de Qualidade da Energia Elétrica, Editora Blucher, 2009
R. N. Allan, R. Billinton, Reliability Evaluation of Power Systems, 2nd Ed., Springer, 1996
S. Santoso, H. W. Beaty, R. C. Dugan, M. F. McGranaghan, Electrical Power Systems Quality, 3rd Ed., McGraw-Hill, 2012
Online Knowledge Library. Available Support Material: lecture notes; notes of practical classes; examples of practical exercises and software in the field of Electric Power Quality.

**Access Conditions and Attendance Excuse**

For students of special schemes, namely those under the worker-student statute it should be agreed upon between the course unit and the student, on the initiative of the latter and at the beginning of the academic semester, an alternative way of functioning of these components, when the student cannot effectively attend them at the scheduled times.

**Conditions for Exam Admission**

All students enrolled in the course unit have access to the final exam, provided that the number of unexcused absences in theoretical and theoretical-practical classes does not exceed 30% of the classes actually taught.

**Evaluation Method**

All students have access to the final examination where the two parts, theoretical and practical, are evaluated separately. The evaluation of each part is accomplished by two intermediate assessment tests. In each part, to waive the final examination is mandatory to achieve a minimum grade of 8.0 values and an average grade equal or greater than 9.5 values. The intermediate assessment tests as well as the final exam are all ranked from 0 to 20 values.
Theoretical part (50%)
– Final written exam; or
– Continuous evaluation: 2 tests T1(30%), T2(30%); Case studies – Teamwork (40%);
Theoretical-Practical part (50%)
– Final written exam; or
– Continuous evaluation: 2 tests TP1(30%), TP2(30%); Teamwork problem solving (40%).
Proposed dates for the intermediate assessment tests:
1st Frequency: April 09, 2019, starting at 6:30 p.m.
2nd Frequency: may 28, 2019, starting at 6:30 p.m.

**Conditions for Results Improvement**

In accordance with the regulation of the Instituto Superior de Engenharia de Coimbra.

**Date**

**21/01/2019**

**Signature from the lecturer responsible for the course**

Carlos Machado Ferreira

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:_____

**Licenciatura – BsC** Engenharia Electrotécnica – 9109 (Português)

**Licenciatura – BsC** Electrical Engineering - 9010 (Inglês)

Academic Year: **2018/2109**

***Program Contents***

**Course Unit** SIGNAL PROCESSING

**Specialization (s)** Electronics and Telecommunications,

**Subject type** Speciality Sciences **Research Area** Electrical Engineering

**Year** 3rd **Semester** 1st **ECTS** 6

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 74 |
| Works / Group Works | 20 |
| Project | - |
| Evaluation | 6 |
| Additional | |

**Total of Working Hours** 156

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Helena Jorge Carvalho da Silva Marto | Mestrado | Prof. Adjunta |
| Theoretical-Practical Lectures | - | - | - |
| Practical-Laboratoty Lectures | Helena Jorge Carvalho da Silva Marto | Mestrado | Prof. Adjunta |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Helena Jorge Carvalho da Silva Marto

**Goals**

To learn and understand basic theory of signals and linear systems with continuous and discrete time and of using system representations based on the Fourier transforms.
To acquire the ability of analyzing and manipulating signals and linear time-invariant systems in both the time and frequency domains.

**Skills**

Students will learn and understand basis of description and analysis of discrete and continuous-time signals and systems. They will also obtain practical skills in analysis and filtering in MATLAB..

**Program Contents**

Continuous and discrete time signals and systems.
Basic operations on signals: operations performed in the dependent variables and operations performed in the independent variables
Unit Step and Unit Impulse;

Signature of Teacher:_____

Exponential Complex Signal (Continuous and discrete time)
Properties of systems: linearity; memory; causality; invertibility; invariance and stability..
Linear time-invariant (LTI) systems.
Impulse Response.
Convolution (Continuous and discrete time). Convolution properties.
LTI systems properties: memory; causality and stability.
Fourier series.
Fourier transforms.
Sampling and reconstruction of signals.

**Bibliography**

A.Oppenheim,A.Willsky and S.Nawab, Signals & Systems, Prentice Hall,1997.
Simon Haykin, Barry Van Veen, Sinais e Sistemas, Bookman, 2001.
B.P. Lathi, Linear Systems and Sinals, Oxford, 2002.
Isabel Lourtie, Sinais e Sistemas, Escolar Editora, 2002.
A.Oppenheim, R.Schafer, Discrete-Time Signal Processing, Prentice Hall, 1999.
John R. Buck, Michael M. Daniel, Andrew C. Singer, Computer Exploration in Signals and Systems using Matlab - second edition, Prentice Hall, 2002

**Access Conditions and Attendance Excuse**

Not applicable.

**Conditions for Exam Admission**
Not applicable.

**Evaluation Method**
Realization of 1 work in Matlab quoted for 3 values. (to be delivered by the examination date) The theoretical / theoretical-practical evaluation, quoted for 17 values, is carried out by 3 intermediate tests or final exam.
The student must have a minimum of 7 values in each test to access the following test.
The 3rd test will be held on the date of the final exam, the student may choose to realize 3rd test or final exam.
Dates of the 1st and 2nd tests: 19/10/2018 and 23/11/2018.
The evaluation moments are without consultation and only scientific calculating machines can be used.

**Conditions for Results Improvement**
It is only allowed to improve classification to the component evaluated in the examination.

| Date | Signature from the lecturer responsible for the course |
|---|---|
| 17 de setembro de 2018 | Helena Paula |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:

**Licenciatura – BsC em Eng. Electrotécnica** (Português)

**Licenciatura – BsC degree in Electrical Engineering** (Inglês)

Academic Year: **20018/2019**

***Program Contents***

**Course Unit** SYSTEMS CONTROL

**Specialization (s)**

**Subject type** Electrical Engineering **Research Area** Electrical Engineering

**Year** 3 **Semester** 1 **ECTS** 6

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 24 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 24 |
| Tutorial Orientation | | |
| Project | | |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 97 |
| Works / Group Works | |
| Project | |
| Evaluation | 3 |
| Additional | |

**Total of Working Hours**

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Horácio do Carmo Fachada | Msc | Assistant Professor |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratoty Lectures | Horácio do Carmo Fachada | | |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Horácio do Carmo Fachada

Signature of Teacher: 

## Goals

The objectives of this course are to introduce the student to the modelling, simulation, and control of linear time-invariant (continuum and discrete) systems.
The application of the Matlab and Simulink environment and toolboxes for simulating the behaviour of engineering systems.
Understand industrial control: PID controllers, digital controllers for position/velocity control loops with encoders and/or other sensors.
Understand the digital implementation of control and basic digital control design techniques.

## Skills

Locating information needed to help make decisions or solve problems.
To advance the capacity to think, to understand principles, and to reason.
Working cooperatively in a group.
Practice in technical writing of the laboratory reports.

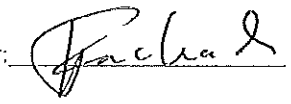
## Program Contents

Introduction to modern control;
State variables and state space concept;
Diagram structures: concept and analysis;
Observability and controllability;
Null and non-null reference state space feedback;
Pole placement and stability; Estimator design;
PID controller design and tuning;
Linearization, amplitude and time scaling;
Sampling and finite difference equations of systems;
Deadbeat controllers: synthesis and behaviour;
Study and simulation of several control problems.

## Bibliography

Dynamical Systems and Automatic Control, J. L. Martins de Carvalho, Prentice Hall
Engenharia do Controlo Moderno, Katsuhito Ogata, Prentice Hall
Applied Digital Control – Theory, Design and Implementation, J. R. Leigh, Prentice Hall

## Access Conditions and Attendance Excuse

Signature of Teacher: 

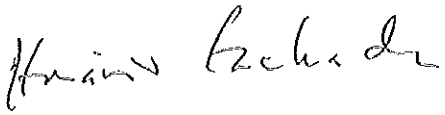
**Conditions for Exam Admission**

**Evaluation Method**

Homework preparation of the laboratory lectures, including extensive use of computer aided simulation & design techniques: 6 values; Final examination: 14 values.

**Conditions for Results Improvement**

Practical classes frequency

| Date | Signature from the lecturer responsible for the course |
| --- | --- |
| 17 September 2018 |  |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:

**Licenciatura – BsC Engenharia Electrotécnica**

**Licenciatura – BsC Electrical Engineering**

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** ELECTRONICS II

**Specialization (s)** AUTOMATION/ELECTRONICS AND TELECOMMUNICATIONS

**Subject type** Mandatory **Research Area** Electrical Engineering

**Year** 3rd **Semester** 1st **ECTS**

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 59 |
| Works / Group Works | 28 |
| Project | 10 |
| Evaluation | 3 |
| Additional | |

**Total of Working Hours**

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | António Luis Ferreira Marques | MsC | Prof. Adjunto |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratoty Lectures | António Luis Ferreira Marques | MsC | Prof. Adjunto |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** António Luis Ferreira Marques

**Goals**

Know and understand the functioning of the various semiconductor devices and its application in medium to high complexity electronic systems.
Analysis and design of electronic circuits in medium to high complexity is also a goal to achieve.

**Skills**

Understand and interpret technical specifications of the components used in electronic circuits.
Know, analyze, design and implement analog electronic circuits of medium to high complexity, namely: oscillators, DC power sources, linear and non-linear systems based on Operational Amplifiers and composite amplifiers (differential and push-pull).
Use simulation tools (Spice).
Know and use correctly test and measurement equipment.
Develop the ability to do group work and to write technical reports

Signature of Teacher:_____

**Program Contents**

1. Oscillators
2. Power sources and voltage Regulators: discrete and integrated.
3. Operational amplifiers in linear and non-linear applications
4. Differential Amplifiers
5. Output stages: Push-pull amplifier.

**Bibliography**

Stanley G. Burns e Paul. R. Bond, Principles of Electronics Circuits, Second Edition, PWS Publishing Company
Sergio Franco, Operational Amplifiers and Analog integrated Circuits, McGraw-Hill
Robert Boylestad e Louis Nashelsky, Dispositivos Electrónicos e Teoria dos Circuitos, Quinta Edição, Prentice-Hall do Brasil
Slides covering topics used in theoretical lessons.
Exercise sheets

**Access Conditions and Attendance Excuse**

Those provided by ISEC evaluation regulation.

**Conditions for Exam Admission**

Obtain a minimum of 3 points in laboratory evaluation.

Maximum of two absences in practical-laboratory lectures.

**Evaluation Method**

Final written Exam (14 points)
Laboratory Works – pré-lab plus report (6 points)

**Conditions for Results Improvement**

It is only possible to improve the component evaluated by exam, in accordance with the regulations of ISEC.

| Date | Signature from the lecturer responsible for the course |
|---|---|
| 17.September.2018 | |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Lecturer's signature:_____

**Licenciatura – BsC Engenharia Electrotécnica** (Português)

**Licenciatura – BsC Electrical Engineering** (Inglês)

## *Program Contents*

**Course Unit** POWER ELECTRONICS

**Specialization (s)** ELECTRICAL ENGINEERING

**Subject type** **Research Area**

**Year** 3rd **Semester** 1st **ECTS** 6

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 42 |
| Works / Group Works | 55 |
| Project | |
| Evaluation | 3 |
| Additional | |

**Total of Working Hours** 156

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Marina Perdigão/ Teresa Outeiro | PhD | Assistant Professor |
| Theoretical-Practical Lectures | | PhD | Assistant Professor |
| Practical-Laboratoty Lectures | Teresa Outeiro | | |
| Tutorial Orientation | | | |
| Project | | | |

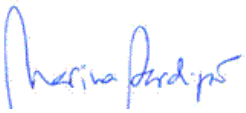
**Responsible(s) Lecturer (s)** Marina Perdigão, PhD; Teresa Outeiro, PhD

**Goals**

Power electronics systems deal with the process of converting electrical power from one form to another. The syllabus reflects the learning objectives of curricular unit.
This curricular unit will start by remembering the basics of power semiconductor devices.
The first presented converter will be the rectifier (ac-dc converter). The discussion of line-current harmonic distortion and input power factor in nonlinear loads will be an important topic for the students' curriculum. Then dc-dc converters and inverters (dc-ac converters) will be introduced. Throughout the course there will be some classes related to power converter modelling, simulation and control, providing to the students basic technical knowledge on the design and implementation of power electronic converters. With the knowledge provided in this curricular unit, the students will be able to have an integrated view of power generation and conversion systems, particularly from the electronic control point of view.

**Skills**

The balance between the presentation of theoretical aspects in classroom lectures and the development of knowledge by students through practical problem solving as well as the execution of simulation and laboratory works, allows a solid learning of the fundamental aspects of the power electronic converters operation, design and control.
It is expected that, with the acquired knowledge and the possibility of analyzing the operation of real converters, the students will be able to understand, design and evaluate the performance of power electronic converters.

Lecturer's signature:_____ 

**Program Contents**

1. Overview of Power Electronics Devices : Seminconductor Devices and Passive Components
2. AC-DC Converters
2.1. Non-controlled rectifiers (diodes).
2.2. Semi-controlled and full-controlled rectifiers (diodes and thyristors).
2.3. Line-current harmonic distortion and input power factor in nonlinear loads.
3. DC-DC Converters
3.1. Introduction, technologies, power topologies and power levels
3.2 Non-isolated topologies
3.3 Isolated topologies
4. DC-AC Converters
4.1. Half-bridge and Full-bridge single-phase Inverter
4.2. Modulation strategies
4.3. Full-bridge three-phase, two and multi-level Inverters
5. Other Converter Topologies
6. Applications
7. Power converter modelling, simulation and control basics

**Bibliography**

*Power Electronics, Converters, Applications and Design*, Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley & Sons, Inc.
*Power electronics : devices, circuits, and applications* by Muhammad H Rashid, Pearson

**Access Conditions and Attendance Excuse**

For students in special conditions (working students, fireman or others) exceptional actions/evaluation procedures are available and defined in the regulation imposed by ISEC-IPC

**Conditions for Exam Admission**

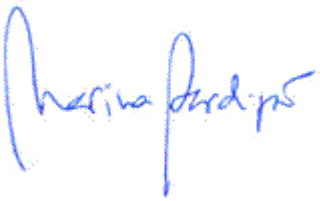
50% average in the Laboratory component

**Evaluation Method**

Final written exam (70%); Laboratory component: Simulation reports (individual assignments) and a final test regarding the knowledge acquired in the lab (30%). Students must have a minimum of 50% in each part to be approved in the subject.

**Conditions for Results Improvement**

Students can only improve the final written exam

| **Date** | **Signature from the lecturer responsible for the course** |
|---|---|
| **25/09/2018** |  |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

**Licenciatura – BsC Engenharia Eletrotécnica - 9109**

**Licenciatura – BsC Electrical Engineering - 9109**

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** POWER SYSTEMS ANALYSIS

**Specialization (s)** Power Systems

**Subject type** Specialty Sciences **Research Area** Electrical Engineering

**Year** 3rd **Semester** 1st **ECTS** 6

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 2 | 28 |
| Practical-Laboratoty Lectures | | |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 156 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 97 |
| Works / Group Works | |
| Project | |
| Evaluation | 3 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Carlos Manuel Borralho Machado Ferreira | PhD | Prof. Coordenador |
| Theoretical-Practical Lectures | Carlos Manuel Borralho Machado Ferreira | PhD | Prof. Coordenador |
| Practical-Laboratoty Lectures | | | |
| Tutorial Orientation | | | |
| Project | | | |
| **Responsible(s) Lecturer (s)** | Carlos Manuel Borralho Machado Ferreira | | |

**Goals**

The main aims of this course unit are:
To model major types of components used in electrical power systems
To analysis fault conditions including both balanced and unbalanced faults
To understand the use of sequence networks in the analysis of faults and unbalanced power system operation
To evaluate the electric power system dynamics and its stability
To acquire knowledge to analyse the security of an electrical power system and propose/implement measures to improve it
To understand the basics of power system protection systems

**Skills**

The main skills of this course unit are:
To know the characteristics and behaviour of an electric power system
To understand and apply the techniques required to analyse the effects of short-circuits in an electric power system
To manage, design, implement and maintain electrical power systems
To design and conduct experiments and to analyse and interpret data
To identify, formulate and solve engineering problems
To communicate in a professional and technical manner, both in written and oral form, the subjects related to this course

**Program Contents**

**1. Short-circuit Analysis**
Introduction
Symmetrical Fault Analysis

Signature of Teacher:

Electrical Power System Models: Generators, Transformers, Lines and Loads
Short Circuit of a Synchronous Machine
Short-circuit Capacity
Algorithm for Short Circuit Studies
Bus Impedance Matrix Formulation
Systematic Fault Analysis using Bus Impedance Matrix
Symmetrical Components
Symmetrical Components Transformation
Sequence Impedances of Generators, Transformers, Transmission Lines and Loads
Construction of Sequence Networks of a Power System
Methods for measurement of symmetrical components
Unsymmetrical Fault Analysis
Symmetrical Component Analysis of Unsymmetrical Faults: Single Line-To-Ground (LG) Fault, Line-To-Line (LL) Fault, Double Line-To-Ground (LLG) Fault, Open Conductor Faults
Bus Impedance Matrix Method for Analysis of Unsymmetrical Shunt Faults
Limitation of short circuit currents

**2. Power Systems Security Analysis**

Introduction
An Overview of Security Analysis, Factors Affecting Power System Security, Detection of Network Problems
Contingency Analysis: Linear Sensitivity Factors, Calculation of Network Sensitivity Factors, AC Power Flow Methods, Contingency Selection
Zbus Methods in Contingency Analysis: Adding and Removing Multiple Lines, Piecewise Solution of Interconnected Systems, Analysis of Single and Multiple Contingencies
System Reduction for Contingency Analysis and Fault Studies

**3. Power System Stability**

Introduction
Dynamics of a Synchronous Machine
Power Angle Equation
Simple Systems
Steady State Stability
Transient Stability
Equal Area Criterion
Numerical Solution of Swing Equation
Multimachine Stability
Some Factors Affecting Transient Stability
Voltage Stability
Comparison of Angle and Voltage Stability

**4. Power System Protection**

Protection concepts
Protective devices and controls, Transmission protection, Apparatus protection
System aspects of protective systems

**Bibliography**

1. J. P. Sucena Paiva, Redes de Energia Eléctrica, uma Análise Sistémica, 3.ª Edição revista, IST Press, 2011
2. A. Gomez-Exposito, A. Conejo, C. Canizares, Electric Energy Systems: Analysis and Operation, 2nd Ed., CRC, 2018
3. M. Delgado, Sistemas Eléctricos Trifásicos – a Média, Alta e Muito Alta Tensão, Publindústria, 2010
4. J. Glover, M. Sarma, T. Overbye, Power System Analysis and Design, 6th Ed., CL-Engineering, 2016
5. H. Saadat, Power Systems Analysis, 3rd Ed., PSA Publishing, 2010
6. M. Delgado, Protecção das Redes Eléctricas de Distribuição, Transporte e Interligação, Publindústria, 2011
7. R. Castro, E. Pedro, Exercícios de Redes e Sistemas de Energia Elétrica, IST Press, 2014

Online Knowledge Library.
Available Support Material: lecture notes; notes of practical classes; examples of practical exercises.

**Access Conditions and Attendance Excuse**

For students of special schemes, namely those under the worker-student statute it should be agreed upon between the course unit and the student, on the initiative of the latter and at the beginning of the academic semester, an alternative way of functioning of these components, when the student cannot effectively attend them at the scheduled times.

**Conditions for Exam Admission**

All students enrolled in the course unit have access to the final exam, provided that the number of unexcused absences in theoretical-practical classes does not exceed 25% of the classes actually taught.

**Evaluation Method**

The evaluation can be done during the semester or in the final exam. All students enrolled in the course unit have access to the intermediate assessment tests, provided that the number of unexcused absences (theoretical and theoretical-practical) does not exceed 30% of the classes actually taught. Students excused from continuous assessment are assessed only by final examination.
During the semester two intermediate assessment tests will be carried out, classified into 0 to 20 values scale. The student obtains approval, in each intermediate test, if he/she obtains a classification equal or greater than 9.5 values. Approved

Signature of Teacher:

students, in each of the intermediate tests, are excused from answering, in the final exam, to the corresponding part of the subject. The final grade will result from the arithmetic mean of the classifications obtained.
The evaluation of the theoretical part is presented in the form of multiple choice questions and development questions. It has a weight of 50% in the final classification, requiring a minimum of 4 values.
The evaluation of the theoretical-practical part is composed by application exercises, being allowed the consultation of a formulas sheet, provided by the teacher. The evaluation of the theoretical-practical part has a weight of 50% in the final classification, requiring a minimum of 4 values. Students are allowed to use a calculator in the theoretical-practical part of the assessments/final exam.
The final classification is obtained by weighting the results of theoretical and theoretical-practical intermediate tests, being mandatory to reach a grade equal or greater than 9.5 values.
Dates of partial evaluation tests:
1st Frequency: November 20, 2018
2nd Frequency: December 18, 2018

**Conditions for Results Improvement**
In accordance with the regulation of the Instituto Superior de Engenharia de Coimbra.

| Date | Signature from the lecturer responsible for the course |
| --- | --- |
| 17/09/2018 | Carla Machado Fonseca |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:

**Licenciatura – Engenharia Eletrotécnica - 9109**

**BSc – Electrical Engineering - 9109**

Academic Year: 2018/2019

***Program Contents***

**Course Unit** ELECTRICAL MACHINES II

**Specialization (s)** POWER SYSTEMS / AUTOMATION

**Subject type** Speciality Siciences **Research Area** Electrical Engineering

**Year** 3rd **Semester** 1st **ECTS** 6

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 156 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 76 |
| Works / Group Works | 20 |
| Project | |
| Evaluation | 4 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Paulo José Gameiro Pereirinha | PhD | Prof. Coordenador |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratoty Lectures | José Ladeira Francisco | 5y "Licenciat." | Assistente Convid. |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Paulo José Gameiro Pereirinha

**Goals**

The main aims of this course unit are:
Knowledge of mechanical construction, principle of operation and equivalent circuits of dc machines and synchronous machines.
Familiarize students with these electrical machines.
Work in electrical machines laboratory environment.

**Skills**

At the end of this course unit the learner is expected to be able:
To test, assemble and work with dc machines and synchronous machines.
To design and conduct experiments, as well as to analyze and interpret data.
To choose technical solutions and participate in projects to implement and maintain these machines.

**Program Contents**

**DC machines:** Mechanical construction. Principle of operation. Armature windings. Emf equation. Armature reaction. Theory of commutation. Power balance, developed torque, and efficiency. Excitation systems. Characteristics of the separately excited, shunt, series and compound generators. Characteristics of the separately excited, shunt, series and compound motors. Starting, braking and reversing operation of dc motors. Speed regulation.
**Synchronous machines:** Principle of operation. Physical constitution. Ac windings. Induced emf equation. Time and space

harmonics. Armature reaction. Synchronous generators: Load operation. Economic tests and generators characteristics. Equivalent circuits. Parallel operation. Synchronous Motors: Power and torque for single-phase and three-phase motors. Effects of excitation and load. Power factor correction. Start of synchronous motors.
**Special-purpose electric machines:** Universal motors, Permanent-magnet motors. Reluctance motors.

## Bibliography

### Main Bibliography

J. Carvalho, "Máquinas de Corrente Contínua ", Monografia, ISEC, 2010 (texto-base)
J. Carvalho, "Máquinas Síncronas ", Monografia, ISEC, 2010 (texto-base)
Paulo Pereirinha, "Máquinas Eléctricas – Introdução", reduced version of the presentation of the lesson for "Professor Coordenador" public defense, Dec. 2008

P. C. Sen, "Principles of Electric Machines and Power Applications", John Wiley & Sons, Inc., Singapore, 1996
B. S Guru, H. R. Hiziroglu, "Electric Machinery and Transformers", Oxford University Press, New York,3rd. rev edition, 2000
S. J. Chapman, Electric Machinery Fundamentals, Mcgraw Hill Higher Education; 5th Revised edition, 2011
I. L. Kosow, "Máquinas Eléctricas e Transformadores", 15ª edição, Editora Globo S. A., São Paulo, 2005
A. E Fitzgerald, C. Kingsley Jr., A. Kusko, *Máquinas Elétricas: com Introdução Eletrônica de Potência*, Editora Bookman, Porto Alegre, Brasil, 2006
M. P. Kostenko, L. M. Piotrovski, "Máquinas Eléctricas I", Editorial Mir, Moscovo, 1979
G. R. Slemon, A. Straughen, "Electric Machines", Addison-Wesley Publishing Company, 1982
D. P. L. Brandão, MáquinasEléctricas - Introdução às Máquinas Eléctricas de Corrente Contínua, Fundação Calouste Gulbenkian, Lisboa, 1984
S. A. Nasar, "Máquinas Eléctricas", McGraw-Hill, Brasil, 1984
M. Fogiel, "The Electrical Machines Problem Solver", Research and Education Association, 1990

Videos, articles and other documents provided by teachers.

## Access Conditions and Attendance Excuse

Signature of Teacher: _____

The practical classes are divided into 50% theoretical-practical classes and 50% of laboratory classes.
**In order to have access to the final exam of the curricular unit, is mandatory the cumulative presence in:**
**- 80% of the laboratory classes;**
**- 65% of the total of all class hours (56 hours of classes planned, means a minimum of 36 hours of participation in theoretical and practical classes).**

And For students of special schemes, namely those under the Worker-Student Statute, and for components with compulsory attendance and distributed assessment, it must be agreed between the person responsible for the curricular unit and the student, on the initiative of the student and at the beginning of the academic semester, a form of alternative functioning of these components, when the student cannot justifiably attend them at the scheduled times.

**Conditions for Exam Admission**
Students who have passed the laboratory component and fulfilled the number of attendances required in the previous point have access to the exam.

**Evaluation Method**
**1. Theoretical and Theoretical-Practical Component (CTTP) -** are evaluated by final exam, consisting of an individual written test, with a minimum grade of 8.5 points.

**2. Laboratory Component (CL) -** operates on a compulsory frequency basis and includes a continuous assessment throughout the semester and a final test.
• **Continuous assessment (AC)**, with a minimum grade of 8.5, includes:
- Attendance: being obligatory to attend 80% of classes;
- Performance: includes group participation, job preparation, execution capacity, response to questions, analysis and treatment of experimental results;
- Reports / Worksheets: being obligatory to deliver 80% of the work, within one week after its completion; delays in delivery will be penalized.
• **Final test of individual assessment of knowledge (TL)**, to be carried out at the end of the laboratory work of the various classes, addresses issues related to laboratory work / reports.
The CL approval implies a minimum grade of 8.5 points and is obtained by the weighted average of the continuous assessment (weight 6) and the final knowledge assessment test (weight 4):

$$CL = (6 \times AC + 4 \times TL) / 10$$

Students who do not obtain the above mentioned minimums will be excluded from the final exam.
**3. Final Classification**
The final classification (CF) is calculated by the weighted average of the CTTP (weight 7) and the CL (weight 3), according to the following expression:

$$CF = (7 \times CTTP + 3 \times CL) / 10$$

Note: Students who do not obtain the minimums in the final exam will not be considered the laboratory grade, and the grade of the exam will be marked to 20 points.
---
**It will not be allowed to consult any formula sheet in the examinations** (in case of particularly complex equations, these will be provided with the exam).

**Conditions for Results Improvement**
1. Theoretical and Theoretical-Practical Component (CTTP): The improvement of the classification can be done by student enrollment within the established deadlines, in one of the two examination periods subsequent to the one in which approval was obtained, excluding the special period.
2. Laboratorial Component (CL): The improvement of classification can be made by enrollment in the previous periods and times and will consist in the accomplishment of a Complementary Laboratorial Test.

**Date**

**17/09/2018**

**Signature from the lecturer responsible for the course**

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

**Licenciatura – Engenharia Eletrotécnica -Diurno – 9109**

**BSc – Electrical Engineering**

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** ELECTRICAL MACHINES I (MÁQUINAS ELÉTRICAS - 910922)

**Specialization (s)** -

**Subject type** Speciality Siciences **Research Area** Electrical Engineering

**Year** 2nd **Semester** 2nd **ECTS** 6,5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | 1 | 14 |
| Project | | |
| **Total of Working Hours** | | 169 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 75 |
| Works / Group Works | 20 |
| Project | |
| Evaluation | 4 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Paulo José Gameiro Pereirinha | PhD | Prof. Coordenador |
| | Marina Mendes Sargento Domingues Perdigão | PhD | Prof. Adjunto |
| Theoretical-Practical Lectures | - | | |
| Practical-Laboratoty Lectures | Paulo Filipe de Almeida Ferreira Tavares | PhD | Prof. Adjunto |
| | José Ladeira Francisco | Degree (5y) | Assistente Conv. |
| Tutorial Orientation | Paulo José Gameiro Pereirinha | PhD | Prof. Coordenador |
| | Marina Mendes Sargento Domingues Perdigão | PhD | Prof. Adjunto |
| Project | | | |

**Responsible(s) Lecturer (s)** Paulo José Gameiro Pereirinha

**Goals**

The main goals of this course unit are:
To understand the basic concepts of electric machines operation in continuous (steady-state) operation. Obtain knowledge on mechanical construction, principle of operation and equivalent circuits and applications of transformers and asynchronous machines, single- and three-phase. Familiarize students with the use of these electrical machines through their use in the laboratory environment.

**Skills**

At the end of this course unit, it is expected that the student will be able to: calculate, connect and work with transformers and asynchronous machines; design and conduct experiments, as well as to analyze and interpret data; learn how to use control systems and protection; choose technical solutions and participate in projects to implement and maintain these kinds of machines.

**Program Contents**

**1. Generic Principles of Electric Machines**

Constitution. Materials. Main physical laws governing the operation of electric machines: Maxwell, Ampere, Faraday, Lenz, Ohm generalized. Electromechanical Energy Conversion.

Signature of Teacher: _____

**2. Single-phase transformer**
Constitution. Operation principle. Equations of operation. Equivalent circuits of the real transformer. Definition of characteristic quantities at rated power. Determination of voltage drops and external characteristics. Losses and efficiency. Economic tests. Grouping in parallel.
**3. Three-phase transformer**
Three-phase bank and three-phase unit. Three-phase transformer core. Types of three-phase transformers, regarding the connection of windings. Operation of the transformer in symmetrical mode. Economic analysis of the amount of copper used on each type of winding. Electrodynamic forces. Grouping in parallel. Study of the three-phase connections from the point of view of the 3rd harmonic and the regime of unbalanced loads.
**4. Special transformers**
Measurement and Protection Transformers: current transformer, voltage transformer. Autotransformer.
**5. Three-phase asynchronous machines**
Constitution. Operation principle. Equations of operation. Equivalent circuit. Motor powers and torque. Electromechanical and mechanical characteristics. Operating stability. Influence of parameters on motor characteristics. Circle diagram. Economic tests. Starting of induction motors: squirrel cage motors; winding rotor motors. Classes of squirrel cage motors. Inverted March. Operation of the asynchronous machine as generator. Operation of the asynchronous machine as a brake.
**6. Single-phase induction motor.**
Constitution. Operation principle. Starting processes of single-phase induction motors. Locked rotor and no-load tests.

## Bibliography

### Main Bibliography

J. Carvalho, "Transformadores ", Monografia, ISEC, 2011 (texto-base)
J. Carvalho, " Motores de Indução ", Monografia, ISEC, 2011 (texto-base)
Paulo Pereirinha, "Máquinas Eléctricas – Introdução", reduced version of the presentation of the lesson for "Professor Coordenador" public defense, Dec. 2008
Videos, photos and animations on electrical machines presented by teachers.

### Other Bibliography

- Jesus Fraile Mora, Máquinas Eléctricas, Garceta, Madrid, 2015
- Jesús Fraile Ardanuy, Jesús Fraile Mora, Problemas resueltos de máquinas eléctricas, Garceta, Madrid, 2ª ed., 2015
- Stephen D. Umans, Máquinas Elétricas de Fitzgerald e Kingsley, 7 Ed., Artmed Editora, junho de 2014
- S.J. Chapman, "Electric Machinery Fundamentals", Mcgraw Hill Higher Education; 5th Revised ed., 2011
- P.C. Sen, "Principles of Electric Machines and Power Electronics", 3rd. ed. Wiley, 2013
- E. Ras, " Transformadores de potencia, de medida y de protección ", 7. Ed., Marcombo, 2009
- I. L. Kosow, "Máquinas Eléctricas e Transformadores", Editora Globo, São Paulo, 2006
- M. P. Kostenko, L. M. Piotrovski, "Máquinas Eléctricas I e II", Editorial Mir, Moscovo, 1979
- Ion Boldea, Syed A. Nasar, Electric Drives, 3rd ed., CRC Press, 2016
- Syed A. Nasar, Máquinas elétricas : 178 problemas resolvidos, 180 problemas propostos, Rio de Janeiro : McGraw-Hill, 1984

Signature of Teacher: _____

**Access Conditions and Attendance Excuse**
**In order to have access to the final exam of the curricular unit, is mandatory the cumulative presence in:**
**- 80% of the laboratory classes;**
**- 65% of the total of all class hours (70 hours of classes planned, means a minimum of 45 hours of participation in theoretical, practical and tutorial classes).**

For students of special schemes, namely those under the Worker-Student Statute, and for components with compulsory attendance and distributed assessment, it must be agreed between the person responsible for the curricular unit and the student, on the initiative of the student and at the beginning of the academic semester, a form of alternative functioning of these components, when the student cannot justifiably attend them at the scheduled times.

**Conditions for Exam Admission**
Students who have been approved on the Continuous assessment (AC) of the laboratory component (CL) and fulfilled the number of attendances required in the previous point have access to the exam.

**Evaluation Method**
**1. Theoretical and Theoretical-Practical Component (CTTP) -** are evaluated by final exam, consisting of an individual written test, with a minimum grade of 8.5 points out of 20.

**2. Laboratory Component (CL) -** operates on a compulsory frequency basis and includes a continuous assessment throughout the semester and an individual written test regarding laboratorial matters.
• **Continuous assessment (AC)**, with a minimum grade of 8.5, includes:
- Attendance: being obligatory to attend 80% of classes;
- Performance: includes group participation, job preparation, execution capacity, response to questions;
- Reports / Worksheets: includes the analysis and treatment of experimental results being obligatory to deliver 80% of the works, within one week after its completion; delays in delivery will be penalized.
• **Test of individual assessment of knowledge (TL)**, to be carried out together with the "Época Normal" exam and/or the "Época de Recurso" exam with a minimum grade of 7.0 points.
The CL approval implies a minimum grade of 8.5 points and is obtained by the arithmetic average of the continuous assessment and the test of individual assessment of knowledge:

$$CL = (AC + TL) / 2$$

**3. Final Classification**
To students who do not obtain the minimum grade in any of the indicated components, the grade of the respective component quoted to 20 points will be released as the final exam classification.
For the remaining cases, the final classification (**CF**) is calculated by the following expression:

$$CF = (2 \times CTTP + CL) / 3$$

**Conditions for Results Improvement**
1. **Theoretical and Theoretical-Practical Component (CTTP):** The improvement of the classification can be done in accordance with the "Regulamento de Avaliação de Conhecimentos e Transição de Ano dos Estudantes das Licenciaturas do Instituto Superior de Engenharia de Coimbra" (REACTA).
**2. Laboratory Component:** The improvement of classification can be made by enrollment according to the REACTA and will consist in the completion of the **individual laboratory test, TL** (together with the corresponding TL in the following year).
If it is possible from the point of view of the functioning of the laboratory classes, and with the agreement of the teacher in charge, the part of **AC** may also be improved in the year following its approval (exceptionally, this component can also be improved through complementary work to be agreed with the teacher).

**Date**

**21/01/2019**

**Signature from the lecturer responsible for the course**

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: IFonseca

**Licenciatura – BsC em Engenharia Eletrotécnica – 9109** (Português)

**Licenciatura – BsC in Electrical Engineering – 9109** (Inglês)

Academic Year: **2018 / 2019**

***Program Contents***

**Course Unit** INDUSTRIAL AUTOMATION AND ROBOTICS

**Specialization (s)** COMMON TRAINING

**Subject type** Specialty Sciences **Research Area** Electrical Engineering

**Year** 2 **Semester** 2 **ECTS** 6

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | - | - |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | - | - |
| Project | - | - |

**Total of Working Hours** 156

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 69 |
| Works / Group Works | 14 |
| Project | 14 |
| Evaluation | 2 |
| Additional | - |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Inácio de Sousa Adelino da Fonseca | PhD | Professor Adjunto |
| Theoretical-Practical Lectures | - | - | - |
| Practical-Laboratoty Lectures | Horácio do Carmo Fachada | MSc | Professor Adjunto |
| Tutorial Orientation | - | - | - |
| Project | | | |

**Responsible(s) Lecturer (s)** Inácio de Sousa Adelino da Fonseca

**Goals**
Teach and ensure that students acquire the skills described below.

**Skills**
Design, project, execute and maintain industrial automation systems.
Design, execute and maintain industrial robotic systems.
Program PLCs and industrial electrical and pneumatic equipment.
Ability to propose technical solutions to the employer or client.
Ability to choose technical solutions and their arguments to the employer or client in the scope of automation and robotics.
Perform and maintain automated robotic systems.
Apply and program simple vision systems.

**Program Contents**

1 - Theoretical classes
a) Introduction to robotics - homogeneous coordinates; Denavit-Hartenberg (DH) method; direct and inverse kinematics; main configurations of industrial robots; Simulators and programming of industrial manipulators; Motoman Programming Language;
b) PLC Programming - Grafcet I, II and III; Grafcet encoding in Ladder; IEC Standards. Specific functions associated with different manufacturers; other programming methodologies;
c) Introduction to supervision and interaction - the importance of Supervisory Control and Data Acquisition (SCADA)

Signature of Teacher: _____

systems; OPC systems (); Human Machine Interaction (HMI) systems;
d) Electrical drawing tools for the industrial automation area - electrical design.

2 - Laboratory classes
1 – Robotics (programming and manipulator)
2 – Robotics (simulator)
3 – Programming tools and Pneumatic work (OMRON)
4 – Jobs: Parts Selection | Variation of speed (OMRON)
5 – Jobs: Parts Selection | Variation of speed (OMRON)
6 – Jobs: Parts Selection | Variation of speed (OMRON)
7 – Work performed in Siemens PLC
8 – Work performed in Siemens PLC
9 – HMI - Tactile console [do either a) or b)]
10 – HMI - Tactile console [do either a) or b)]
a) Working with touch console - OMRON;
b) Working with touch console - Siemens;
11 – Supervision [do either a) or b)]
12 – Supervision [do either a) or b)]
a) *ZENON SCADA Software - Parts Selection (two weeks);*
b) *WinCC SCADA Software - Parts Selection (two weeks);*
13 – Conclusion of works / Laboratory defense;
14 – Laboratory defense.

Note: For classifications higher than 16, students must do extra work, one and only one from these two:
a) Elaborate the simultaneous selection of parts in the parts selector in Omron and / or Siemens;
b) Control a motor connected to a speed inverter / PLC pair, via a remote PLC.

**Bibliography**


1 - "Automação industrial", 5th edition, revised and enlarged, J. Norberto Pires, ISBN: 978-972-8480-31-8, (Lidel, 2012);
a) It covers topics of automation and also of robotics - Denavit-Hartenberg method - kinematics and dynamics of manipulators;
b) Alternative: "Robótica industrial", J. Norberto Pires, ISBN: 978-989-752-226-0, (Lidel, 2018);
2 - "Autómatos Programáveis", 5th edition updated, António Francisco, ISBN: 978-972-8480-33-2, (ETEP, 2015);
a) Alternative: "Curso de Automação Industrial", Paulo Oliveira, ISBN: 978-972-8480-21-9, (ETEP, 2009);
b) Alternative: "Técnicas de Automação", J.R. Caldas Pinto, ISBN: 978-972-8480-26-4, (ETEP, 2010);
3 - Manufacturers' Catalogs (Manipulators, PLCs and Manuals of Training Courses);
4 - Manuals from Siemens, Omron, Caddy, Zenon, Motoman and Scorbot manipulators;
5 - Statements of practical work, Slides of theoretical classes.
6 - Videos elaborated - demonstrating how to use the different technologies - Omron, Siemens, Caddy, Zenon, Motoman.


**Access Conditions and Attendance Excuse**
For students under the Worker-Student Statute, and for components with compulsory attendance and distributed assessment, it may be agreed upon by the teacher responsible for the curricular unit and the student, adjustments to the functioning of these components.
In this case, during the first two teaching weeks, the students must indicate to their respective teacher their status as student worker, establishing immediately how to adjust the functioning of the referred components. The presentation of the employer's work time or other relevant information may be required.

**Conditions for Exam Admission**
It is necessary to obtain a minimum grade higher than 20% in the Laboratory component.
Presence in 75% of laboratories.

**Evaluation Method**
Written Exam for theoretical evaluation - 12 values (The written exam has a minimum grade of 20%).
Laboratory classes - 8 values
The evaluation of the laboratory classes is done as follows (items of the **Program Contents** - laboratory part):
Item 2 - 2 values (completion of class work) - term a;
Item 4, 5, 6, 7, 8 - 3 values (conclusion of class work) - term b;
Item 9, 10 – 1.5 values (conclusion of class work) - term c;
Item 11, 12 – 1.5 values (completion of class work) - term d;

Note: Individual defense. The quotation attributed to the defense = 0% to 100%, and will be applied retroactively to the evaluations of the previous points, the evaluation being given by:

laboratory evaluation = defense * (term a + term b + term c + term d)

Defense = individual laboratory test with 3 random written questions about the lab. work, with 60 minutes to make the test - takes place, if possible, in the laboratory classes of the last week of classes (in a semester with 14 effective weeks of classes), with submission to the moodle.

Signature of Teacher: I Fonseca

Students with a mark higher than 16 should prove in an oral defense with the teacher of the theorists to maintain the classification. If they do not wish to make this defense the note will be limited to 16 values.
Students who wish to classify higher than 16 values can perform a work described in section 6) of the **Program Contents** of the laboratory classes

**Conditions for Results Improvement**
In accordance with the legislation in force.

| **Date** | **Signature from the lecturer responsible for the course** |
|---|---|
| **18-01-2019** | Ines Fonseca |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: 

**Licenciatura – BsC Engenharia Electrotécnica (Cód. *9109)***

**Licenciatura – BsC - Electrical Engineering**

Academic Year: **2018/2019**

## Program Contents

**Course Unit** ELECTRONICS

**Specialization (s)** Common Formation

**Subject type** Mandatory **Research Area** Electrical Engineering

**Year** 2nd **Semester** 2nd **ECTS** 6.5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratory Lectures | 2 | 28 |
| Tutorial Orientation | 1 | 14 |
| Project | | |
| **Total of Working Hours** | | 169 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 68 |
| Works / Group Works | 28 |
| Project | |
| Evaluation | 3 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | António Luis Ferreira Marques | MsC | Prof. Adjunto |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratory Lectures | António Luis Ferreira Marques | MsC | Prof. Adjunto |
| | Marco José da Silva | MsC | Assist. Conv |
| Tutorial Orientation | António Luis Ferreira Marques | MsC | Prof. Adjunto |
| Project | | | |

**Responsible(s) Lecturer (s)** António Luis Ferreira Marques

**Goals**

Know and understand the functioning of the various semiconductor devices and its application in simple electronic systems. Analysis and design of electronic circuits of basic to medium complexity is also a goal to achieve.

**Skills**

Know and understand the operation of semiconductor devices.
Analyze and understand the features and technical specifications of the components used in electronic circuits.
Analyze, Design and Implement analog electronic circuits of basic to medium complexity .
Use simulation tools (Spice).
Know and use correctly test and measurement equipment.
Develop the ability to do group work and to write technical reports.

**Program Contents**

1. Semiconductor Diodes and Applications
2. Bipolar Junction Transistors and DC Biasing. Application circuits.
3. Field Effect Transistors and DC biasing. Application circuits.
4. Discrete Amplifier analysis, with BJT's and FET's.

Signature of Teacher:

**Bibliography**

Robert Boylestad e Louis Nashelsky, *Dispositivos Electrónicos e Teoria dos Circuitos*, 11ª Edição, Prentice-Hall do Brasil, 2013
Albert Malvino, *Princípios de Electrónica*, Vol. 1 e 2, Sétima Edição, McGraw-Hill, 2007
Albert Malvino and David Bates, *Electronic Principles* (8th Edition), McGraw-Hill Education, 2015
Adel Sedra and Kenneth Smith, *Microelectronic Circuits (7th Edition),* Oxford University Press, 2014
Slides covering topics used in theoretical lessons.
Tutorial on using Spice simulator.
Exercise sheets.

**Access Conditions and Attendance Excuse**

Those provided by ISEC evaluation regulation.

**Conditions for Exam Admission**

Obtain a minimum of 3 points in laboratory evaluation.

Maximum of two absences in laboratory lectures.

*The conditions of access are valid for all examination periods.*

**Evaluation Method**

Final Exam (13 points)
Participate and intervention in Tutorial classes (1 point)
Laboratory Works – pré-lab plus report (6 points)

**Conditions for Results Improvement**

It is only possible to improve the component evaluated by exam, in accordance with ISEC regulations.

| Date | Signature from the lecturer responsible for the course |
|---|---|
| 11.february.2019 | |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Lecturer's signature: _____

**Licenciatura – BSc** *Engenharia Eletrotécnica* - 9109

**Licenciatura – BSc** *Electrical Engineering* - 9109

Academic Year: **2018/2019**

## *Program Contents*

**Course Unit** ELECTRICAL POWER SYSTEMS

**Specialization (s)** Power Systems

**Subject type** Specialty Sciences **Research Area** Electrical Engineering

**Year** 2 **Semester** 2 **ECTS** 5.5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 2 | 28 |
| Practical-Laboratoty Lectures | | |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 143 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 84 |
| Works / Group Works | |
| Project | |
| Evaluation | 3 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Carlos Manuel Borralho Machado Ferreira | Doutoramento | Prof. Coordenador |
| Theoretical-Practical Lectures | Carlos Manuel Borralho Machado Ferreira | Doutoramento | Prof. Coordenador |
| Practical-Laboratoty Lectures | | | |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Carlos Manuel Borralho Machado Ferreira

**Goals**

Electrical Power Systems (EPS) is a course designed for students of all branches of electrical engineering, and it's a standard content.
Students begin by learning a general description of an EPS in the aspects of production, transmission, distribution and consumption. Then, mathematical models of the major components are developed. That will allow the learning of basic analysis tools, in this case the power flow analysis. Finally, protection systems and SCADA is studied in a more descriptive way. In practical classes, are presented and studied problems that allow the students gradually consolidate the knowledge that was given in theoretical lectures. Here, concepts of financial and economic analysis are also presented, that allow students to understand how the electricity price it's formed.

**Skills**

Understand the organization, operating principles and mode of operation of an Electric Power System (EPS).
Know the basic tools for modelling and analysis of an EPS.
Know how to model the different components of an EPS (transformers, synchronous machines, electric power lines and loads).
Learn how to solve the power flow problem (Gauss-Seidel method, Newton-Raphson method, Fast Decouple Load Flow method and DC model).
Know the equipment and operating principles of the protection systems of an EPS.
Understand and apply concepts of financial and economic analysis in determining the costs of producing electricity.

**Program Contents**

1. Fundamental concepts of EPS
   - Overview of an EPS
   - Forms of electricity production and its environmental impacts
   - Fundamentals of analysis of power grids

Lecturer's signature: _____

2. Study and modelling of components
   - Transformers
   - Synchronous machine
   - Transmission lines
   - Loads
3. Analysis of power flow
   - Construction of admittance matrix
   - Basic equations of a power flow
   - Gauss-Seidel method
   - Newton-Raphson method
   - Decoupling and rapid decoupling
   - DC model
4. Protection systems fundamentals
   - Types of short circuits
   - Protection Systems
   - Surges
   - Protection with voltage dischargers
   - Insulation coordination
5. Concepts of economic and financial analysis
   - Value for money
   - Cost of energy produced
   - Market prices
   - Economic evaluation of investment
6. Introduction to SCADA

**Bibliography**

1. J. P. Sucena Paiva, Redes de Energia Eléctrica, uma Análise Sistémica, 4.ª Edição, IST Press, 2015
2. Hadi Saadat, Power Systems Analysis, 3rd Ed., PSA Publishing, 2011
3. John J. Grainger, William D. Stevenson, Jr., Power System Analysis, McGraw-Hill International Editions, 1994
4. B. M. Weedy, J. Cory, N. Jenkins, J. B. Ekanayake, G. Strbac, Electric Power Systems, 5th Ed., Wiley, 2012
5. Rui Castro, Eduardo Pedro, Exercicios de Redes e Sistemas de Energia Eléctrica, 2.ª Edição, IST Press, 2015

Online Knowledge Library. Available Support Material: lecture notes; notes of practical classes; examples of practical exercises.

**Access Conditions and Attendance Excuse**

For students of special schemes, namely those under the worker-student statute, it should be agreed upon between the course unit and the student, on the initiative of the latter and at the beginning of the academic semester, an alternative way of functioning of these components, when the student cannot effectively attend them at the scheduled times.

**Conditions for Exam Admission**

Be enrolled in the course unit.

**Evaluation Method**

All students have access to the final examination where the two parts, theoretical and practical, are evaluated separately. The final classification is obtained by the formula:

FC (Final classification) = 0.5xTheoretical_exam_value + 0.5xPractical_exam_value

There is the possibility of continuous assessment, where the student can waive the theoretical part, the practical part or both of the final exam. The evaluation of each part (theoretical and practical) is accomplished by two intermediate assessment tests. In each part, to waive the final examination is mandatory to achieve a minimum grade of 8.0 values and an average grade equal or greater than 9.5 values.
The intermediate assessment tests and the final exam are all ranked from 0 to 20 values.
Proposed dates for intermediate assessment tests:

1st Frequency: April 10, 2019, starting at 16h:30m
2nd Frequency: May 29, 2019, starting at 16h:30m

**Conditions for Results Improvement**

In accordance with the regulation of the Instituto Superior de Engenharia de Coimbra.

| Date | Signature from the lecturer responsible for the course |
|---|---|
| 21/01/2019 | Carlos Machado Ferreira |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: Rita Pereira

**Licenciatura – BsC em Engenharia Electrotécnica** *Diurno - 9109* (Português)

**Licenciatura – BsC Electrical Engineering Degree** (Inglês)

Academic Year: **2018 / 2019**

***Program Contents***

**Course Unit** ELECTRICAL INSTALLATIONS I

**Specialization (s)**

**Subject type** Specialty Sciences **Research Area** Electrical Engineering

**Year** 2 **Semester** 2 **ECTS** 5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 2 | 28 |
| Practical-Laboratoty Lectures | | |
| Tutorial Orientation | | |
| Project | | |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 71 |
| Works / Group Works | |
| Project | |
| Evaluation | 3 |
| Additional | |

**Total of Working Hours** 130

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Rita Manuela da Fonseca Monteiro Pereira | PhD | Prof. Adjunto |
| Theoretical-Practical Lectures | Rita Manuela da Fonseca Monteiro Pereira | PhD | Prof. Adjunto |
| Theoretical-Practical Lectures | Rita Manuela da Fonseca Monteiro Pereira | PhD | Prof. Adjunto |
| Practical-Laboratoty Lectures | Maria de Fátima Coelho Monteiro | PhD | Prof. Adjunto |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Rita Manuela da Fonseca Monteiro Pereira

**Goals**

It is intended that students who attend this course to gain comprehensive knowledge about the formation, operation, sizing and design of electrical installations. Providing knowledge on sizing transformer stations and knowledge of technical rules for protection of electrical installations and sizing of the conductor elements. Encourage "best practices" in this field. Giving students the importance of protecting people and animals in electrical installations.

**Skills**

Provide students with a comprehensive knowledge of electrical systems and components.
Provide students with the most important concepts about the equipment and drivers who are part of an electrical installation, as well as the basic tools for its project.
Provide students with the knowledge of technical standards for the protection of electrical installations and promote good practice in this area.

- Becoming aware of the importance of protecting people and animals in electrical installations and provide knowledge of various methods used for this purpose.

Signature of Teacher:_____

**Program Contents**

- An overview of electrical installations
- Transformers stations
- Sets appliances
- Electric conductors
- Busbar
- Conception of electrical installations. Evaluation of potency expected. Factors concurrency and utilization
- Rating locations. Factors external influences.
- Structure of the premises. Location of switchboards.
- Characteristics of electrical conduits. Sizing circuits. Establishment eletrical Installation modes and types of installations conductors
- Protection of eletrical instalations
- Protection of people and animals. Differential devices. Type of ground connections.
- Protections against overvoltages of atmospheric origin
- Power factor compensation
- Safety and rescue generatores

**Bibliography**

Regras Técnicas das Instalações Eléctricas de Baixa Tensão.
Hilário Dias Nogueira, ABC das Regras Técnicas, Publindustria, 2011.
António Augusto Araújo Gomes e José António Beleza Carvalho, Instalações Elétricas de Média Tensão Postos de Transformação e Seccionamento (2ª Edição), Engebook, abril de 2018.
António Augusto Araújo Gomes, Instalações Elétricas de Baixa Tensão (2ª Edição), Publindústria, abril de 2015.
António Augusto Araújo Gomes, Henrique Jorge de Jesus Ribeiro da Silva e José António Beleza Carvalho, Instalações Elétricas de Baixa Tensão Dimensionamento e Proteção de Canalizações Elétricas, Publindústria, março de 2017.
António Gomes, Sérgio Ramos e André Sá, Instalações Elétricas de Baixa Tensão Aparelhagem de proteção, comando e seccionamento, Engebook, novembro de 2018.
José Marinho Gomes Pereira e Josué Lima Morais, Guia Técnico das Instalações de Baixa Tensão, Certiel.
Notes from theoretical classes
Notes from theoretical-practical classes

**Access Conditions and Attendance Excuse**

For students of special schemes, namely those under the worker-student statute, it should be agreed upon between the course unit and the student, on the initiative of the latter and at the beginning of the academic semester, an alternative way of functioning of these components, when the student can not effectively attend them at the scheduled times.

**Conditions for Exam Admission**

All students enrolled in the course unit.

**Evaluation Method**

The assessment of acquired skills will be a final exam on all the material taught, with a maximum score of 20 points, with 10 marks for theorical part and 10 marks for the practical part. In order to obtain approval the student must have at least 9.5 marks in the sum of the two parts, but simultaneously fulfill the minimum of 4 marks in each one of the parts.

**Conditions for Results Improvement**

In accordance with the legislation.

| **Date** | **Signature from the lecturer responsible for the course** |
|---|---|
| **18/01/2019** | |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:

**Licenciatura – BSc Engenharia Eletrotécnica (9109)**

**Licenciatura – BSc Electrical Engineering**

Academic Year: **2018/2019**

***Program Contents***

| | | | |
|---|---|---|---|
| **Course Unit** | MICROPROCESSORS | | |
| **Specialization (s)** | COMMON | | |
| **Subject type** | mandatory | **Research Area** | Electrical Engineering |
| **Year** | 2 | **Semester** | 1 |
| | | **ECTS** | 6.5 |

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 169 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 55 |
| Works / Group Works | 55 |
| Project | |
| Evaluation | 3 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Fernanda de Madureira Coutinho | PhD | Prof. Adjunto |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratoty Lectures | Marco José Silva | MSc | Assistente Conv. |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Fernanda de Madureira Coutinho

**Goals**

To understand the operation of a microprocessor/microcontroller.
To learn how to program an embedded system based on a microprocessor/microcontroller, using low level and high level programming languages (Assembly and C, respectively).

**Skills**

Programming of embedded systems based on 8 bit microprocessors/microcontrollers.

**Program Contents**

Overview about the design of embedded systems based on microprocessor/microcontroller. Cross development tools. Microprocessor operation. Data and program memories. Data, control and address buses.
Case study - i8051 microcontroller: external architecture; I/O space; data and code memory maps; address decode; interrupt management system; internal peripherals (timers, serial interface); programming of the µC8051 in Assembly, in C and in C with Assembly inline.
Multiprocessor systems: master-slave architecture.
Overview about other commercial microcontrollers.

Laboratory Classes
The laboratory classes are held in the Microprocessor Lab.
The classes are organized in such a way as to provide students with practical work involving the µC8051F340 development board, simulation tools (MCU8051IDE simulator) and real peripherals.
The proposed laboratory works are as follows:

Signature of Teacher:_____

1) Work 1 (1 lesson) - Cross-Development. Tool MCU8051IDE and Board C8051F340.
2) Work 2 (2 lessons) - Access to the Input and Output Space
3) Work 3 (2 lessons) - Access to Data and Code Address Spaces
4) Work 4 (2 lessons) - Timers. Pooling and Interruptions
5) Work 5 (2 lessons) - External Interruptions
6) Work 6 (2 lessons) – Serial Channel. Pooling and Interruptions
7) Support for the Final Work (classes remaining until the end of the semester)

**Bibliography**

[1] D. Ibrahim. Microcontroller projects in C for the 8051, Newnes. ISBN 0-7506-4640-3.
[2] M. Predko. Programming and customizing the 8051 microcontroller, McGraw-Hill. ISBN 0-07-913646-X.
[3] V. Júnior. Aplicações práticas do microcontrolador 8051, Editora Érica. ISBN 85-7194-194-7.
[4] S. Mackenzie. The 8051 Microcontroller, Prentice Hall. ISBN 0-02-373660-7.
[5] S. Yeralan, A. Ahluwalia. Programming and Interfacing the 8051 Microcontroller, Addison Wesley. ISBN 0-201-63365-5
[6] K. Ayala. Aplicações Práticas do Microcontrolador 8051, West Publishing Company. ISBN 0-314-20188-2.
[8] F. Coutinho. Tópicos de Programação de Sistemas Embebidos. Available on moodle platform.
[9] Fernanda Coutinho. "Programação do microcontrolador 8051 em Assembly. Available on moodle platform.
[10] Silicon Labs, C8051F340 Datasheet (https://www.silabs.com/documents/public/data-sheets/C8051F34x.pdf).

**Access Conditions and Attendance Excuse**

N/a

**Conditions for Exam Admission**

Free access, subjected to applicable conditions according to ISEC regulations.

**Evaluation Method**

Written Exam – 13 points out of 20, with minimum required grade of 5 points out of 13. The classification can be dependant on subsequent realization of an additional exam or oral test, in case it is found to be necessary for better evaluation of students competences.
Project – 7 points out of 20, without minimum required grade. This component may be obtained only by students that have missed no more than 2 laboratory classes. The presentation and oral discussion is mandatory.

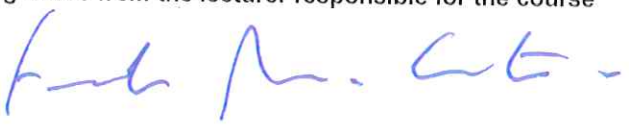
**Conditions for Results Improvement**

There is a single deadline for project submission and presentation, so it is not possible to improve this component. The written exam grade may be improved according to applicable regulations.

**Date**

14/09/2018

**Signature from the lecturer responsible for the course**



Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

**Licenciatura – BsC** *em Engenharia Eletrotécnica - 9109*

**Licenciatura – BsC in Electrical Engineering** - *9109*

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** THEORY OF SYSTEMS

**Specialization (s)** COMMON TRAINING

**Subject type** ENGINEERING SCIENCE **Research Area** ELECTRICAL ENGINEERING

**Year** 2 **Semester** 1 **ECTS** 6.5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 2 | 28 |
| Practical-Laboratoty Lectures | | |
| Tutorial Orientation | 1 | 14 |
| Project | | |
| **Total of Working Hours** | | 169 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 60 |
| Works / Group Works | |
| Project | 30 |
| Evaluation | 3 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Nuno Miguel Fonseca Ferreira | PhD | Prof. Adjunto |
| Theoretical-Practical Lectures | Carlos Alberto da Rocha Lebres | Msc | Eq. Prof. Adjunto |
| Practical-Laboratoty Lectures | | | |
| Tutorial Orientation | Carlos Alberto da Rocha Lebres | Msc | Eq. Prof. Adjunto |
| Project | | | |

**Responsible(s) Lecturer (s)** Nuno Miguel Fonseca Ferreira

**Goals**

Teach systematic methods to the student for performance analysis of linear dynamic systems, as well as methods for designing automatic feedback control algorithms for linear systems.

**Skills**

Analyze the performance of linear dynamic systems.
Designing automatic feedback control algorithms for linear systems.

**Program Contents**

1. Brief historical description of the evolution of systems theory and control.
2. Algebra of block diagrams, canonical form of a control system, transformation of block diagram, overlap of various input signals, simplification of block diagram, block diagram and mathematical models, rule of mason.
3. Mathematical models, forms of mathematical representation: differential equation, Laplace transform, transfer function. Linearization. Time response from the transfer function: decomposition into partial fractions, transient regime and location of poles of the system. Theorems of initial value and final value.
4. Analysis of open-loop systems in the time domain, study of the behavior of the system described by a differential equation of constant coefficients. Description of a system through its transfer function, analysis of the transient response of first and second order systems and high order, a system of order higher than two can be obtained as a linear combination of the lowest order responses. Routh-Hurwitz stability criterion, zeros effect on step response.
5. Analysis of feedback systems in the time domain. Algebra of block diagrams, permanent regime analysis, root locus method, rules for the construction of the root locus diagram.

Signature of Teacher:

6. Analysis of the systems in the frequency domain, open-loop analysis, frequency response graphical plot, polar diagrams, goat diagram, Nyquist stability criterion. Closed loop analysis, relative stability, delayed feedback systems analysis.
7. Study on controllers, forms of control of feedback systems, ON-OFF controllers and linear controllers. Presentation of the proportional (P), integral (I) and derivative (D) actions, saturation by effect of the integral action presentation of empirical methods for the calibration or tuning of controllers, open loop methods and closed loop methods. Cascade control and feedforward control, compensation for phase advance or delay, and PI action.

**Bibliography**

[A1] J. L. Martins de Carvalho, "Dynamical Systems and Automatic Control", Prentice Hall International Series in Systems and Control Engineering, 1993, ISBN: 0-13-221755-4

[A2] Katsuhiko OGATA, "Modern Control Engineering", Third Edition, Prentice Hall, Inc.

**Access Conditions and Attendance Excuse**

For special schemes, namely those under the Worker-Student Statute, and for components with compulsory attendance and distributed assessment, it must be agreed between the responsible for the curricular unit and the student, on the initiative of the student and at the beginning of the academic semester, a form of alternative functioning of these components, when the student cannot attend them at the scheduled times

**Conditions for Exam Admission**

All students enrolled in the course will have access to the exam.

**Evaluation Method**

The Theoretical classes are complemented with practical examples and the practical classes are applied the knowledge acquired in the theoretical, complemented by solving exercises of real applications. The assessment throughout the semester is made through three tests, the first test is the minimum of 9.5 and the others have the minimum value of 7.5. The final classification is calculated as the arithmetic average of the three grades. The dates of completion are: 30 of October, 27 of November and 11 of December, 2018. Will be two written exams exam (1st call time and resource), within the time fixed by the Pedagogical Council. All written tests include theoretical and practical questions and the students have 2 hours to resolve the test. The final grade will be the grade given to the written test. In any of these assessments it is necessary to obtain a rank equal to or higher than 10.

**Conditions for Results Improvement**

The improvement of classification will be done through a global evaluation process, in order to allow the improvement of all evaluation components. Through a research work to improve the practical component and final exam in one of the allowed times.

| Date | Signature from the lecturer responsible for the course |
|---|---|
| 17/09/2018 | |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: P.F.

**Licenciatura – BsC** Engenharia electrotécnica – Diurno 9109

**Licenciatura – BsC** Electrical engineering – Daytime 9109 (

Academic Year: 18 / 19

***Program Contents***

**Course Unit** ELECTROMAGNETISM

**Specialization (s)** COMMON CURRICULUM

**Subject type** Basic sciences **Research Area** Physics

**Year** 2º **Semester** 1º **ECTS** 5.5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 1 | 14 |
| Practical-Laboratoty Lectures | 1 | 14 |
| Tutorial Orientation | | |
| Project | | |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 70 |
| Works / Group Works | 14 |
| Project | |
| Evaluation | 3 |
| Additional | |

**Total of Working Hours** 143

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Paulo Jorge Ribeiro da Fonte | Habilitation | Prof. Coordenador |
| Theoretical-Practical Lectures | Susete Teresa Gaspar do Fetal | PhD | Prof. Adjunto |
| Practical-Laboratoty Lectures | Paulo Jorge Ribeiro da Fonte | Habilitation | Prof. Coordenador |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Paulo Jorge Ribeiro da Fonte

**Goals**

In this course will be acquired competences on the understanding of Nature in the domain of the Electromagnetic phenomena, emphasizing the most technologically important concepts. The theoretical studies are complemented with laboratory work

**Skills**

It is developed the knowledge and ability to understand the field of electromagnetism, leaning on the high-school level of expertise and on adequate and updated texts of international authors.
The knowledge acquired is promoted by conducting theoretical and practical exercises and applied in the laboratories, which develop a professional attitude towards work.
The student is compelled to engage in situations of a practical nature (laboratories) or theoretical-practical (written examinations) where he should carry out judgments and decisions.
The subjects taught are largely basic concepts of scientific and technical literacy, relevant to a broad understanding of nature and applications, and in the communication of ideas with scientific basis. The laboratory group work allows exercising interpersonal exchanges of ideas and discussion of problems and solutions.
The individual study of the subjects taught, supported by tutorial contacts, forms an important part of the work plan, acquiring the students habits of autonomous acquisition of knowledge.

Signature of Teacher: 

**Program Contents**

**1. Recapitulation of Vector Analysis**

The mathematical concepts of the scalar field and vector field. Examples of some physical quantities that are represented by fields.
Graphic representation of the fields: equipotential surfaces and field lines.
Derivation of the fields in a translation and rotation invariant form
-The operator nabla.
Gradient of a scalar field: definition and meaning.
Divergence of a vector field: definition and meaning.
Rotational vector fields: definition and meaning.
The Laplacian and other second derivatives: the most important properties.
Irrotational, solenoidal and harmonic fields. Potential vector and scalar potential.
Integrals over the fields
Volume integrals on scalar fields. Meaning and important special cases.
Line and surface integrals on vector fields. Meaning and important special cases. Flux and circulation of a vector field.
The Gauss and Stokes theorems
Flux tubes. Continuity equation.
Differential operators in curvilinear coordinate systems. Spherical and cylindrical coordinates.

**2. Introduction to Electromagnetism**

The phenomenology of Electromagnetism: charges, currents, electric field, magnetic field, electric and magnetic forces, electromagnetic waves.
Fundamental electromagnetic relations: Maxwell equations, Lorentz force, law of conservation of electric charge. Main simplified approaches.
Linearity of the fundamental equations: the principle of superposition.

**3. Electrostatics**

The Maxwell's equations and Lorentz force in a electrostatic situation.
Gauss' law. Electrostatic application to various simple situations. Coulomb's law. Electric dipole and electric dipole moment. Calculation of the electric field of a known charge distribution from the principle of superposition. Volume, surface and linear charge distributions.
The electric potential. Equations of Poisson and Laplace and its application to various simple electrostatic situations. Meaning and physical properties of the electric potential. Potential energy. Power and energy in electrical circuits. Kirchhoff's loop rule.
Conductors in the electrostatic situation. Relaxation time. Boundary conditions. Distribution of electrical energy.
Systems of conductors in electrostatic equilibrium. Field lines, flux tubes and matching elements. Coefficients of capacity. Insulated conductor.
Spherical, cylindrical and plane capacitors. General relationship between current and voltage in a capacitor. Capacitive impedance. Capacity and stored energy. Volumetric density of electrical energy.
Dielectrics. Susceptibility electrical permittivity and relative permittivity .

**4. Electric Current**

Definition of intensity and density of electric current.
The law of conservation of charge in differential form. Integral form: Kirchhoff's point rule. Influence of the displacement current.
Charge transport in ohmic materials. Microscopic Ohm's law. Conductivity and resistivity of materials. Superconductivity. Lines of current flux and flux tubes of the current density. Electrical resistance and Ohm's Law. Resistance of linear conductors.

**5. Magnetostatics**

The currents as sources of magnetic induction. Magnetic forces.
The Maxwell's equations and Lorentz force in magnetostatic situation. Mathematical properties of the magnetic field. Magnetic field lines, circulation and flux.
Ampere's Law. Application to various simple magnetostatic situations: rectilinear conductor; infinite plane of current; solenoid.
Relationship between electrostatic and static magnetic fields. Magnetic field generated by a single moving charge. Calculation of the magnetic induction field generated by a current distribution by applying the principle of superposition: Biot-Savart's law. Application to various simple magnetostatic situations.
Movement of charged particles in electric and magnetic fields. Gyromagnetic ratio and cyclotron frequency. Analysis of some instruments.
Magnetic forces exerted on a straight current. Analysis of some particular situations. Force and moment exerted on a coil. Magnetic dipole moment. Some applications and associated phenomena: universal motor, nuclear magnetic resonance, magnetic attraction of ferromagnetic materials.
Magnetic field in materials. Diamagnetic, paramagnetic and ferromagnetic materials. Hysteresis cycle.

**6. Electromagnetic induction**

Electromotive force induced in a conductor in motion and its relationship with Faraday's law. Faraday generator. Faraday generator efficiency. Related Applications: electromagnetic brake, asynchronous motor and generator.
The Maxwell's equations in the presence of magnetic fields in varying in time. Quasi-static approximation. Laws of Faraday and Lenz.
Law of the meshes in the presence of magnetic fields varying in time. Electromotive force induced in a circuit. Principle of the alternator.
Self- induction. General relationship between current and voltage of an inductance. Inductive impedance. Stored energy. Space density of magnetic energy. Calculation of the coefficient of self induction in several simple situations.
Systems of two circuits. Coefficients of mutual induction. The ideal transformer.

**7. Electromagnetic Radiation**

The Maxwell equations in a vacuum.
Solution for plane and spherical electromagnetic waves. Polarization. Light as an electromagnetic phenomenon.
Harmonic waves. Phase velocity, wave number, wavelength, frequency, period. Electromagnetic spectrum.
Energy of the electromagnetic field. Poynting vector and its flux.
Field of radiation of the dipole antenna. Directivity and polarization.
Electromagnetic waves in the material media.

**Bibliography**

Physics for scientists and engineers, v.2, 5ª edition, Mosca e Tipler
The Feynman Lectures on Physics v.2, R.P. Feynman, R.B. Leighton, M.Sands, Addison-Wesley, Reading, Massachusetts, 1964.
Vector Analysis and an introduction to tensor analysis, M. R. Spiegel, Schaum Publishing Company, 1959

**Access Conditions and Attendance Excuse**

The laboratory classes are mandatory, except for the students to which special regimes are applicable.

**Conditions for Exam Admission**

Approval on the laboratory classes (at least 2.00 points).

**Evaluation Method**

The final written examinations foreseen in ISEC's regulations, with a maximum of 20 points (E).

The laboratory work is evaluated by short written reports to be discussed orally, with a maximum of 4 points (L).

Students who obtain a grade of 2 or higher in the laboratory work will obtain approval if C = Ex0.8 + P ≥ 9,500, with E being the final exam classification, quoted from 0 to 20 values, and P the classification of the laboratory work ( 0 to 4 values). Otherwise, the final classification will be C if C <9,000 or 9 if C≥9,000.

Written exams are multiple-choice with 10 questions with 4 possible choices. The correct answers will have a score of 2, and the wrong answers will have a score of -0.66.

The exams are with consultation of an A4 sheet with arbitrary content and calculator.

**Conditions for Results Improvement**

Those foreseen in ISEC's regulations. There will be no improvement of the laboratory component.

| Date | Signature from the lecturer responsible for the course |
|---|---|
| 17/09/2018 | PAULO J. N FONTE |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

**Licenciatura – BsC Engenharia Electrotécnica - 9109**

**Licenciatura – BsC Electrical Engineering - 9109**

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** PROBABILITY AND STATISTICS

**Specialization (s)**

**Subject type** **Research Area** Mathematics

**Year** 2nd **Semester** 1st **ECTS** 5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 2 | 28 |
| Practical-Laboratoty Lectures | | |
| Tutorial Orientation | | |
| Project | | |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 71.5 |
| Works / Group Works | |
| Project | |
| Evaluation | 2.5 |
| Additional | |

**Total of Working Hours** 130

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Luís Manuel Santos Melo Margalho | PhD | Adjunct Professor |
| Theoretical-Practical Lectures | Luís Manuel Santos Melo Margalho | PhD | Adjunct Professor |
| Practical-Laboratoty Lectures | | | |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Luís Manuel Santos Melo Margalho

**Goals**

It is intended that students acquire basic concepts of statistics and probability, including the language and rules inherent to these concepts

**Skills**

It is intended that the student has the skills to identify techniques that allow the statistical analysis of data and perform, if necessary, statistical inference, possibly resorting to statistical software.

**Program Contents**

1. **Probabilities**. Definitions. Properties. Conditional Probability. Independence. Theorems of total probability and Bayes.

2. **Discrete Random Variables**. Definition. Probability function and distribution function. Expected value, variance and properties. Binomial and Poisson laws. Bidimensional variables. Joint probability and distribution functions, marginal probability, conditional probability. Independence. Covariance and correlation.

3. **Continuous variables**. Definition. Probability density function and distribution function. Expected value, variance and properties. Uniform, normal and exponential laws. Central Limit Theorem. Applications.

Signature of Teacher:_____

4. **Estimation. Statistical Inference**. Point estimation. Properties. Confidence interval for the mean of a normal population with known/unknown variance, to the variance of a normal population and to parameters of non-normal populations.

5. **Parametric Hypothesis Tests**. Concepts and methodology. Testing the expected value, the proportion and the variance. Comparing expected values, proportions and variances of two populations

In case of time availability, a brief introduction will be made to software for statistical analysis of data, with application to the programmatic contents described here.

**Bibliography**


- Pedrosa, A.C., Gama, S. M. A. – Introdução Computacional à Probabilidade e Estatística, Porto Editora
- Bowker and Lieberman - Engineering Statistics, Prentice Hall
- Guimarães, Rui C. & Cabral, José A. S. - Estatística, Mc Graw Hill
- Murteira, Bento et all – Introdução à Estatística, Mc Graw-Hill
- Ross, Sheldon – Introduction to Probability ans Statistics for Engineers and Scientists, Elsevier
- Notes provided by the teacher


**Access Conditions and Attendance Excuse**

**Conditions for Exam Admission**

Access to the exam is allowed to all students duly enrolled in the course unit.

**Evaluation Method**

The final exam evaluation consists of an exam graded for 20 points, in regular season or appeal season, lasting 2h30m. Student will be approved if the grade is, at least, 10 points.

If the exam grade is higher than 18 points, the student must undergo an additional test. In case of no attendance to this additional test, the grade of 18 points will be awarded.

The use of graphic / CAS calculators will not be allowed.

**Conditions for Results Improvement**

According to the conditions in use at ISEC

| **Date** | **Signature from the lecturer responsible for the course** |
|---|---|
| **10/09/2018** | Luís Manuel Santos Ribeiro Magalhães |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

**Licenciatura – BsC** Engenharia Electrotécnica *9109* (Português)

**Licenciatura – BsC** Electrical Engineering *9109* (Inglês)

Academic Year: **2018/2109**

***Program Contents***

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**Course Unit** INSTRUMENTATION AND MEASUREMENT

**Specialization (s)** Automation, Electronics and Telecommunications, Power Systems

**Subject type** Basic Sciences **Research Area** Electrical Engineering

**Year** 1st **Semester** 2nd **ECTS** 5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 44 |
| Works / Group Works | 28 |
| Project | |
| Evaluation | 2 |
| Additional | |

**Total of Working Hours** 130

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Helena Jorge Carvalho da Silva Marto | Master | Prof. Adj. |
| Theoretical-Practical Lectures | - | - | - |
| Practical-Laboratoty Lectures | Helena Jorge Carvalho da Silva Marto | Master | Prof. Adj. |
| | José Pedro Nogueira Amaro | PhD | Prof. Adj. |
| Tutorial Orientation | - | - | - |
| Project | - | - | - |

**Responsible(s) Lecturer (s)** Helena Jorge Carvalho da Silva Marto

**Goals**

The main aims of this course unit are to:
Teach the students the importance of experimental methods in solving engineering problems; Explain the students how to operate, configure and select electronic instruments and measuring systems.

**Skills**

At the end of this course unit is the learner is expected to be able to: use electronic instruments and understanding their principles of operation; validate and interpret the results of measurements; 3) understand the basics of Metrology; develop and implement automatic data acquisition systems.

Signature of Teacher:

**Program Contents**

Introduction to Measurement systems: Functional descriptions of measuring systems; null and deflection methods; input-output configuration of instruments and measurement systems; static characteristics. Types of errors. Statistics.
The Oscilloscope.
Operational Amplifiers, Instrumentation Amplifiers
Digital to analog converters and Analog to digital converters.
Transducers Fundamental Concepts
Interference Signals and Their Elimination or Reduction.
Data acquisition systems, Signal conditioning
Virtual Instrumentation: introduction to LabVIEW

**Bibliography**

MORA, JESÚS FRAILE; GUTIÉRREZ PEDRO GARCIA; ARDANUY, JESÚS FRAILE, Instrumentación aplicada a la Ingeniería, 3ª Edicion, Iberarceta, 2013(Biblioteca ISEC, cota: 1-6-338)

ELFRICK, ALBERT D.; COOPER, WILLIAM D, Instrumentação Electrônica Moderna e Técnicas de Medição, Prentice-Hall do Brasil, 1994.

WOLF, S ; SMITH, R., Student Reference Manual for electronic Instrumentation laboratories, Pearson Prentice-Hall International, USA,

JONES, L.; CHIN, A., Electronic Instruments and Mesurements. Prentice-Hall International, Inc. República de Singapura, 1991.

BISHOP, ROBERT H., Learning with Labview 7 Express, Prentice Hall, International, USA,2004,ISBn0-13-117605-b

Leonard Sokoloff, Applications in LabVIEW, Pearson - Prentice Hall, 2004, ISBN 0-13-016194-2.

**Access Conditions and Attendance Excuse**

Not applicable

Conditions for Exam Admission
Have a minimum of and a minimum of 3.2 values (on 8) on the final laboratory grade.
Students have access to examination with a maximum of two absences in laboratory classes and a minimum of 40% on the average of laboratory tests.

**Evaluation Method**

The theoretical evaluation (12 values )is carried out by 2 tests or final exam.
- Students must have a minimum of 7 values (in 20) in the 1st test to access the second. Students with no minimum of 7 on the 1st frequency will go to normal examination.
- The first frequency will be held on April 12 and the second on the day of the final exam, and students may choose to take the second or exam.
- Approval subject to obtaining a positive classification in the theoretical component.

- The laboratory evaluation is done through 2 laboratory tests and the works done in the classes (these can have preparation and / or reports).
Laboratory approval is subject to the following rules: Obtain a minimum of 40% on the average grades of two laboratory tests (to be done in class) and a minimum of 40% on the average of the grades of the reports / preparations.

**Conditions for Results Improvement**

It is only allowed to improve classification to the component evaluated in the examination.

**Date**

January 21, 2019

**Signature from the lecturer responsible for the course**

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

**Licenciatura – BsC** ____ *Engenharia Eletrotécnica* _____(Português)

**Licenciatura – BsC** ___*Electrical Engineering* _____(Inglês)

Academic Year: _**2018_/_2019**_____

## *Program Contents*

**Course Unit** ELECTRICAL CIRCUITS THEORY II

**Specialization (s)** ELECTRICAL ENGINEERING

**Subject type** Basic Sciences **Research Area** Electrical Engineering

**Year** 1º **Semester** 2º **ECTS** 5,5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 2 | 28 |
| Practical-Laboratoty Lectures | | |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | **134** |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 36 |
| Works / Group Works | 36 |
| Project | |
| Evaluation | 2 |
| Additional | |

**Lecturer** **Manuel Travassos Valdez.**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Manuel Travassos Valdez | PhD | Prof. Adjunto |
| Theoretical-Practical Lectures | Manuel Travassos Valdez | PhD | Prof. Adjunto |
| Practical-Laboratoty Lectures | | | |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Manuel Travassos Valdez

### Goals

The objective of curricular unit I is

- to impart knowledge and understanding essential to solve circuits-phase AC sinusoidal, transient phenomena in linear electric circuits, using the acquired data /knowledge in Electrical Fundamentals I.
- to give students the principles and basic concepts of electric circuits analysis for single-phase AC circuits, and resonance phenomena.

### Skills

students should be able to:

- recognize and interpret the nominal characteristics,
- know how to use and assemble electrical circuits.

-Determining the resonant frequency of circuits with inductors and capacitors
-Calculating the quality factor of a network
-Determining the bandwidth of a network

-Using the techniques of frequency and magnitude scaling.

-Learning the distinction between single-phase and polyphase systems
-Becoming familiar with working with both Y- and -connected three-phase sources
-Becoming familiar with working with both Y- and -connected networks
-Mastering the technique of per-phase analysis of three-phase systems

-Determination of the characteristic damping factor and resonant frequency for both series and parallel RLC circuits
-Calculation of the complete (natural plus forced) response of RLC circuits

**Program Contents**

## Frequency Response

Parallel Resonance
More about Parallel Resonance
Series Resonance
Other Resonant Forms
Scaling

## Polyphase Circuits

Polyphase Systems.
Single-Phase Three-Wire Systems.
Three-Phase Y-Y Connection.
The Delta Connection.
Power Measurement in Three-Phase Systems.

## Transient response of basic circuits

RL circuits. RL circuits under DC supply. RL circuits under AC supply. Applying the continuous flux linkage law to L circuits. RC circuits. Discharging and charging a capacitor. RC circuits under DC supply. RC circuits under AC supply. Applying the continuous charge law to C-circuits. The applications of the unit-step forcing function. RLC circuits. RLC circuits under DC supply.

(a) Series connected RLC circuits.
(b) Parallel connected RLC circuits.
(c) Natural response by two nonzero initial conditions.

RLC circuits under AC supply.
Transients in RLC resonant circuits.

(a) Switching on a resonant RLC circuit to an AC source.
(b) Resonance at the fundamental (first) harmonic.
(c) Frequency deviation in resonant circuits.
(d) Resonance at multiple frequencies.

Switching off in RLC circuits.
(a) Interruptions in a resonant circuit fed from an AC source.

**Bibliography**


- - Matthew Sadiku, Charles Alexander, Sarhan Musa, "Applied Circuit Analysis", Science Engineering & Math; McGraw-Hill Higher Education, 1 edition (1 July 2012). ISBN-13: 978-0071317825.
- William Hayt, Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis", eighth edition, McGraw-Hill Higher Education 2012. ISBN: 9780071317061.
- - A. H. ROBBINS AND W.C. MILLER, "Circuits Analysis: Theory and Practice", 3rd Edition, Clifton Park, NY, Thomson, Delmar Learning, 2004.
- - A. H. ROBBINS AND W.C. MILLER, "Circuits Analysis: Theory and Practice", 3rd Edition, Thomson Delmar Learning, 2004.
- - A. M. DAVIS, "Some Fundamental Topics in Introductory Circuit Analysis: A Critique", IEEE

Transactions on Education, Vol. 43, No. 3, August 2000.

- - C. K. ALEXANDER, M. SADIKU, "Fundamentals of Electric Circuits", NY, McGraw Hill Science/Engineering/Math, 3rd Edition, 2006.
- - CHARLES K. ALEXANDER, MATTHEW SADIKU, "Fundamentals of Electric Circuits", McGraw Hill Science/Engineering/Math, 3rd Edition, 2006.
- - E. HUGHES AND I. MCKENZIE-SMITH, Electric and Electronic Technology, Prentice Hall, 2002.
- - EDMINISTER J. A., "Circuitos Eléctricos", Schaum Ed., Mc- Graw-Hill, 3rd, Rotating Electrical Machinery, Indiana, USA, 1990.
- - EDWARD HUGHES, "Electric and Electronic Technology", Prentice Hall, 2002.
- - M. GUSSOW, Schaum's Outline of Basic Electricity, McGraw-Hill Publishing Co., NY, 2nd Edition, 2007.
- - T. L. FLOYD, Principles of Electric Circuits, Prentice Hall, 7th Edition, 2003.

- THOMAS L. FLOYD, "Principles of Electric Circuits", Prentice Hall, 7th Edition, 2003.

Available support materials:-

> problems/exercises sheets

> practical work worksheets

**Access Conditions and Attendance Excuse**

**Conditions for Exam Admission**

Students can have total access to the exam.

**Evaluation Method**

The student must take a written test, not having a grade lower than 9,5 points. The written exam is quoted for 20 values (0-20).
Three tests will be performed, each one being quoted for 20 values. In order to pass the course, students must have at the same time:
• Average of the classifications of the three tests greater than or equal to 9.5 values;
• Attendance of at least 75% of the total theoretical-practical classes up to the date of each evaluation test (this requirement may not apply to students with student worker status or students in other situations, which will be analyzed on a case-by-case basis).

- The first test refers to the programmatic contents of the topic Resonance and will be held on March 27 at 5:30 p.m.
- The 2nd test corresponds to the topic Three-Phase Circuits and will be held on May 15 at 5:30 p.m.,
- The 3rd test corresponds to the topic Transient Phenomena and will be performed on the day of normal examination.

**Conditions for Results Improvement**

In accordance with the regulations in force at the Higher Institute of Engineering of Coimbra

**Date**

**15/01/2019**

**Signature from the lecturer responsible for the course**

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: Verónica Vasconcelos

**Licenciatura – BsC Engenharia Electrotécnica** (Português)

**Licenciatura – BsC - Electrical Engineering** (Inglês)

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** COMPUTER PROGRAMMING

**Specialization (s)** BASIC SCIENCE

**Subject type** Mandatory **Research Area** Electrical Engineering

**Year** 1st **Semester** 2nd **ECTS** 5.5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratory Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 143 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 60 |
| Works / Group Works | |
| Project | 25 |
| Evaluation | 2 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Verónica Vasconcelos | PhD | Assistant Professor |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratory Lectures | Verónica Vasconcelos | PhD | Assistant Professor |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Verónica Vasconcelos

**Goals**

At the end of this course unit the learner is expected to be able: Apply the proper data structures to computer-based proposed engineering problems. Acquire the indispensable programming techniques / tools to solve, write, debug and test, small and medium applications using the C programming language. Be able to work in a team and write technical reports.

**Skills**

To understand functions with array arguments
To know, understand and be able to apply sorting and searching algorithms;
To understand and be able to apply the concepts of memory allocation;
To understand and be able to apply the data structures: struct and files;
To understand the concepts and be able to apply dynamic data structures;
To understand the principles of Object-Oriented Languages;
To develop teamwork and written communications skills.

Signature of Teacher:_____

**Program Contents**

Arrays and functions; Memory allocation; Sorting and searching algorithms; Data structures; Text and binary files: function to handle data files; Dynamic data structures: Linked lists; Introduction to Object-Oriented Languages.

**Bibliography**

K. N. King, " C Programming – A Modern Approach", Norton & Company, 2nd Ed., 2008

Herbert Schildt, "Teach Yourself C", McGraw-Hill, 3rd Ed, 1998

**Access Conditions and Attendance Excuse**

Those provided by law.

**Conditions for Exam Admission**

Have obtained a minimum of 3 / 6 values in the project.

Maximum of two absences in practical-laboratory lectures.

*The conditions of access are valid for all periods of examination*

**Evaluation Method**

Final written exam (14 values);
Project (6 values). Expected submission date for the project: May 26th, 2019.

**Conditions for Results Improvement**

It is only possible to improve the component evaluated by exam, in accordance with the regulations of ISEC.

**Date**

**January 15, 2019**

**Signature from the lecturer responsible for the course**

Veronica Jacques

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

**Licenciatura em Engenharia Eletrotécnica**

**BSc in Electrical Engineering**

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** DIGITAL ELECTRONIC SYSTEMS

**Specialization (s)**

**Subject type** **Research Area** Electrical Engineering

**Year** 1 **Semester** 2 **ECTS** 5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 130 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 36 |
| Works / Group Works | 36 |
| Project | |
| Evaluation | 2 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | João Carlos Ramos Perdigoto | MSc | Invited Professor |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratoty Lectures | Nuno Ferreira | PhD | Professor |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** João Carlos Ramos Perdigoto

**Goals**

To provide the theoretical and practical aspects of the analysis and synthesis of digital systems (combinational and sequential). To provide an introduction to digital systems design using computational tools to specification with hardware description languages, simulation and synthesis.

**Skills**

To know, understand, and apply learning to use sizing systems.
To know and understand the principles of Digital Systems.
Understanding and mastering the Boolean Algebra.
To know, understand the combinational circuits from the point of view of analysis and synthesis.
To know, understand and learn the circuits and sequential state machines in terms of analysis and synthesis.
To know, understand and learn to use reconfigurable logic circuits.
To know and understand flowcharts and technical design of systems.
To know, understand, and apply learning to use sizing systems.

Signature of Teacher: _____

**Program Contents**

1 - Numbering Systems
- 1.1 The binary numbering system, octal and hexadecimal
- 1.2 Conversion of bases, binary and arithmetic
- 1.3 Representation of negative numbers: codes and complement arithmetic.
- 1.4 Multiplication and division
- 1.5 Digital codes

2 Introduction to Digital Systems

3 Boolean Algebra
- 3.1 Postulates of Huntington and DeMorgan's theorems
- 3.2 Logical functions
- 3.3 Truth tables
- 3.4 Simplifying logic functions: Algebraic Manipulation and Karnaugh maps
- 3.6 Method of Quine-McCluskey

4 Combinatorial Circuits
- 4.1 Ports and logic circuits
- Symbols and their meaning
- Logic circuits: analysis, synthesis and conversions.
- Electrical characteristics and relationship
- 4.2 Combinational Circuits: Analysis and synthesis.
- 4.3 Decoders and encoders
- 4.4 Multiplexer and demultiplexer
- 4.5 Comparators
- 4.6 Adders and subtractors

5 Sequential circuits and Counters
- 5.1 Elements of Memory: latchs and flip-flops
- 5.2 Synchronous sequential circuits
- 5.3 Counters

6 Sequential circuits and state machines
- 6.1 Sequential Circuits and Finite State Machines: Mealy and Moore models
- 6.2 Synthesis and analysis procedures
- 6.2 Simplification of sequential circuits
- 6.3 Equivalence between Moore and Mealy model

7 Reconfigurable logic circuits.
- 7.1 PLD, CPLDs, FPGAs
- 7.2 Configuration tools

**Bibliography**

"Sistemas Digitais, Princípios e Prática", Morgado Dias; FCA.
"Logic and Computer Design Fundamentals", Morris Mano e Charles Kime, Prentice-Hall.
"Electrónica Digital" , L. Cuesta; A. Gil Padilla; F. Remiro, Schaum McGraw-Hill
"Digital design" J.F. Wakerly;. ISBN: 0-13-089896-1
http://www.verilogwiki.info/wiki/index.php/Tutorials
http://www.prenhall.com/mano/

**Access Conditions and Attendance Excuse**

Signature of Teacher: _____

In accordance with the academic regulations and applicable laws.

**Conditions for Exam Admission**

All lab works must have been done (2 misses at maximum).

**Evaluation Method**

All lab works must be executed (2 misses at maximum).
Laboratory experiments and projects – 5 values.
Final Exam – 15 values
Less than 40% in any classification of the previous items, student will not pass.
Final total grade must be more than 9.5 in 20 to pass.

## Grade Scale (0 to 20).

**Conditions for Results Improvement**

In accordance with the academic regulations and applicable laws.

**Date**

**January, 18th, 2019**

**Signature from the lecturer responsible for the course**

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: J S Branco

*Licenciatura – BsC* ***Engenharia Electrotécnica (9109)***

*Licenciatura – BsC* ***Electrical Engineering (9109)***

Academic Year: **2018 / 2019**

## *Program Contents*

**Course Unit** MATHEMATICS APPLIED TO ELECTRICAL ENGINEERING (910908)

**Specialization (s)** COMMON FORMATION

**Subject type** Mathematics **Research Area** Basic Sciences

**Year** 1º **Semester** 2º **ECTS** 4.5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 2 | 28 |
| Practical-Laboratoty Lectures | | |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 117 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 45 |
| Works / Group Works | 13 |
| Project | |
| Evaluation | |
| Additional | 3 |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | João Ricardo de Oliveira Branco | PHD | Adj. professor |
| Theoretical-Practical Lectures | Carla Isabel Florêncio Fidalgo | PHD | Adj. Professor |
| | João Ricardo de Oliveira Branco | PHD | Adj. professor |
| Practical-Laboratoty Lectures | | | |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** João Ricardo de Oliveira Branco

**Goals**

- Study of ordinary differential equations, especially linear equations.
- Explore some numerical methods to solve differential equations.
- Differential equations on electronics.
- Develop the mathematical concepts of Laplace transform and series.
- Application examples using series.
- Relate the mathematical concepts of differential equation, Laplace transform and series with others already acquired, acquiring in parallel or that will be acquired on future course units.

**Skills**

- Understand and apply the concepts of differential equation, Laplace transform and series.
- Develop the capacity to use mathematical techniques to solve problems, interpret and discuss results, in Electrical Engineering context.
- Developing autonomy to use technical texts on engineering.

Signature of Teacher: JW Blanco

**Program Contents**

1. Ordinary differential equations.
   - 1.1 Introduction.
     - Definitions.
     - Initial and boundary value problems.
     - Solutions.
     - Existence and uniqueness of solution.
   - 1.2 First order ordinary differential equations.
     - Separable differential equation.
     - Homogeneous equation.
     - First order linear equation.
     - Bernoulli's equation.
     - Riccati's equation.
   - 1.3 Linear homogeneous differential equations of order n and constant coefficients.
     - System of fundamental solutions. Wronskian.
     - General solution.
     - The differential operator. Characteristic equation.
   - 1.4 Linear complete differential equations of order n and constant coefficients.
     - General integral.
     - Undetermined coefficients method.
     - Variation of constants method.
   - 1.5 Numerical methods for solving ordinary differential equations.
     - Explicit Euler's method.
   - 1.6 Application examples on Electrical Engineering.
2. Laplace transform.
   - 2.1 Introduction.
     - Definition.
     - Sufficient conditions for the existence of Laplace transform.
   - 2.2 Properties of Laplace Transform.
     - Linearity.
     - Differentiation in time domain.
     - Shifting in s-domain.
     - Differentiation and integration in s-domain.
     - Integration in time domain.
     - Convolution of functions. Using convolution for Laplace transform.
     - Laplace transform of periodic function.
     - Heaviside step function. Time shifting.
   - 2.3 Table of Laplace transform.
   - 2.4 Inverse Laplace transform.
   - 2.5 Applications to linear differential equations of order n and constant coefficients.
3. Series.
   - 3.1 Numerical series.
     - Definition. Sequence of partial sums. Convergence.
     - Geometric and Mengoli series.
     - Necessary condition for converge of a series.
     - Integral test.
     - Dirichlet series.
     - Direct comparison test and limit comparison test.
     - D'Alembert and Cauchy criteria.
     - Absolutely convergent and conditional convergence series.
     - Alternating series. Leibniz criterion.
   - 3.2 Power series.
     - Definition. Interval and radius of converge.
     - Representation of functions using power series.
     - Differentiation and integration of power series.
     - Taylor and MacLaurin series.
     - Function expansions using power series. Uniqueness of power series expansions.
   - 3.3 Fourier series.
     - Fourier's theorem.
     - Even and odd functions. Sine and cosine series.

**Bibliography**

- Branco, J.R., *Applied Mathematics to Electronics*, ISEC, 2019;
- Branco, J.R., *Applied Mathematics to Electronics – Exercise book*, ISEC, 2019;
- Gouveia, M.L., Rosa, P., *Apontamentos de Matemática Aplicada,* ISEC, 2008;
- Krasnov, M. L., Makarenko, G., *Problemas de Equações Diferenciais Ordinárias,* McGraw-Hill;
- Kreyszig, E., *Advanced Engineering Mathematics*, John Wiley;
- Ross, S., *Differential Equations*, John Wiley;
- Stewart, J., *Cálculo* (Vol.II), Pioneira - Thomson Learning;
- Swokowski, E. W., *Cálculo com Geometria Analítica* (Vol.II), McGraw-Hill;
- Zill, D., *A first course in differential equations with modelling applications*, Thomson Learning.

**Access Conditions and Attendance Excuse**

Not applicable.

**Conditions for Exam Admission**

Any student enrolled at this curricular unit has access to an examination.

**Evaluation Method**

The assessment may be done in two ways (chosen by the student):

Final assessment:

Final exam, quoted for 20 values and with a duration of 2 hours and 30 minutes. Exam may be done at regular season and at appeal season. Student will be approved if the exam result, rounded, is greater or equal than 10 values.

Distributed assessment:

Two tests (test 1 and test 2), each one quoted for 10 values and with a duration of 1 hour and 30 minutes.
**Test 1** will focus on Chapter 1 and on sections 2.1, 2.2 and 2.3 of Chapter 2, and may be done at following moments:

- 2019/April/17, at 4.30 p.m.,
- at regular season exam,
- at appeal season exam.

**Test 2** will focus on sections 2.2, 2.3, 2.4 and 2.5 of Chapter 2 and Chapters 3, as well as the contents of Chapter 1 essential to understanding those ones, and may be done at following moments:

- 2019/May/31, at 2.30 p.m.,
- at regular season exam,
- at appeal season exam.

Final result will be given by the summation of the grades of both tests. Student will be approved if final result, rounded, is greater or equal than 10 values and the result of each test is greater or equal than 3.5 values (out of 10).

**Conditions for Results Improvement**

According to "REACTA - *Regulamento de Avaliação de Conhecimentos e Transição de Ano dos Estudantes das Licenciaturas do Instituto Superior de Engenharia de Coimbra".*

| **Date** | **Signature from the lecturer responsible for the course** |
|---|---|
| January 21st, 2019 | José Ricardo de Oliveira Branco |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: João Cardoso

**Licenciatura – BsC Engenharia Eletrotécnica** (Português)

**Licenciatura – BsC Electrical Engineering** (Inglês)

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** CALCULUS II

**Specialization (s)**

**Subject type** Basic Sciences **Research Area** Mathematics

**Year** 1 **Semester** 1 **ECTS** 5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 2 | 28 |
| Practical-Laboratoty Lectures | | |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 130 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 71 |
| Works / Group Works | |
| Project | |
| Evaluation | 3 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | João António Ribeiro Cardoso | PhD | Coordinator Prof. |
| Theoretical-Practical Lectures | João António Ribeiro Cardoso | | |
| Practical-Laboratoty Lectures | | | |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** João António Ribeiro Cardoso

**Goals**

- Understand and apply the basic concepts of differentiation and integration of functions with several variables;
- Find the derivatives and integrals of functions with several variables;
- Understand and apply the basic concepts of vector analysis;

**Skills**

The syllabus defined allow, in particular, that the students become aware of the importance of mathematics and its pivotal role as a basic science and supporting tool to a logical and structured reasoning indispensable to understand the specific subjects of electrical engineering. They also contribute to develop skills of abstraction and demonstration on the subjects taught, namely on differentiation and integration of functions with several variables.

**Program Contents**

1. Functions with several variables and their derivatives

Conics and quadrics; Basic concepts of topology; Domains; Level curves; Graphs; Limits and continuity; Partial derivatives; Higher order derivatives; Differentiability; Tangent plane and normal line; Directional derivative and the gradient vector; Local maximum and minimum; Saddle points; Second order derivatives tests for functions with two variables; Constrained

extrema – Lagrange multipliers.
2. Multiple Integrals
*Double Integrals:* Definition; Properties; Geometric meaning; Evaluation; Applications; Polar coordinates; Double integrals in polar coordinates.
*Triple Integrals:* Definition; Properties; Geometric meaning; Evaluation; Applications; Cylindrical and spherical coordinates; triple integrals in cylindrical and spherical coordinates.
3. Vector Analysis
Parametric coordinates; Line integrals and applications; Vector fields; rotational and divergent.

**Bibliography**

H. Anton, I. Bivens e S. Davis, Cálculo – Volume II, 8ª edição, Bookman, 2007
João R. Cardoso, *Apontamentos de apoio às aulas teóricas de Análise Matemática II,* DFM, ISEC, 2019
João R. Cardoso, *Caderno de exercícios das aulas teórico-práticas de Análise Matemática II,* DFM, ISEC, 2019
Finney, Weir e Giordano, *Cálculo*, Volume 2, Addison Wesley, 2003
Larson, Hostetler, Edwards, *Cálculo*, Volume 2, McGraw-Hill, 8ªEd, 2006
James Stewart, Calculus – Early Transcendentals, Thomson, 6ªEd, 2008

**Access Conditions and Attendance Excuse**
Attendance of 60% of the total lectures/problem solving lessons is mandatory just for students that choose the continuous evaluation method; this is not mandatory for students choosing a final examination method.

**Conditions for Exam Admission**
Every student enrolled in this course can attend the continuous evaluation, and the first and second call of final exams

**Evaluation Method**
This course unity is essentially formative and attempts to coordinate the theoretical foundations with the developments needed in the subsequent course unities included in the curriculum. At this level, the intuitive understanding of the concepts and calculation skills are promoted. In Theoretical-Practical lessons the expository and interrogative method is used during the explanation of the theoretical subjects and exercises are solved in groups or individually.

Assessment
Continuous Assessment: There are two examination tests, where each one is rated to 10 points. The 1st Test is on April 10, 2019 and 2nd Test is on June 18, 2019. To be successful in this unit course, students need to:

- Get a minimal score of 3.25 points in each one
- The sum of the classifications has to be greater than or equal to 9.5;
- Attend at least to 60% of the total lectures/problem solving lessons.

Assessment by Final Examination: There is a final exam, rated for 20 points, where the approval requires a score greater than or equal to 9.5 points.

**Conditions for Results Improvement**
Results' improvement is only possible in the second call examination.

**Date**

**21/01/2019**

**Signature from the lecturer responsible for the course**

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:

**Licenciatura – BsC __em Engenharia Eletrotécnica_** (Português)

**Licenciatura – BsC __ in Electrical Engineering __**(Inglês)

Academic Year: _2018_/_2019_

***Program Contents***

**Course Unit** SOFTWARE TOOLS FOR ENGINEERING

**Specialization (s)**

**Subject type** Specialty **Research Area** Electrical Engineering

**Year** 1 **Semester** 1 **ECTS** 4

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures<br>Theoretical-Practical Lectures<br>Practical-Laboratoty Lectures<br>Tutorial Orientation<br>Project | 3 | 42 |
| **Total of Working Hours** | | 104 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 19 |
| Works / Group Works | |
| Project | 40 |
| Evaluation | 3 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | | | |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratoty Lectures | MARIA DE FÁTIMA COELHO MONTEIRO<br>TERESA FRAGOSO | Doutoramento<br>Doutoramento | Prof. Adjunta<br>Prof. Adjunta |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Maria de Fátima Coelho Monteiro

**Goals**

This course has as main objective to provide students with knowledge about some of the computational tools usually used in the context of Engineering (in particular Electrical Engineering ) as well as technical drawing , seen as a communication tool for engineers and technicians from other areas of knowledge, such as architects.
Also provide conditions for development of social skills, teamwork and oral and written communication development.

**Skills**

At the end of the course the student should demonstrate:
- To know, understand, interpret and execute technical drawings;
- Know, understand and use technical drawing tools;
- To know, to understand and to use tools of design and design of electric and electronic circuits.
- Know, understand and know how to use the basic MatLab tools.
- Demonstrate oral and written communication skills.

Signature of Teacher:_____

**Program Contents**

1. Technical drawing
2. Study of the main tools of AutoCAD
3. Practical applications: draw with AutoCad
4. Execution of technical documents technical oral presentations
4. Electrical and electronic circuit design: Orcad
5. Introduction to Matlab

**Bibliography**

Simões Morais, Desenho Técnico, Porto Editora.

Luís Veiga da Cunha, Desenho Técnico, Fundação Calouste Gulbenkian, 6ª Edição.

Pedro Leão Neto, AutoCad 2002, FCA editores.

AutoCAD 2007 & AutoCAD LT 2007 Curso Completo, José Manuel Garcia, FCA editores.

AutoCAD 3D 2007 Curso Completo, João Santos, FCA editores.

Manuais on-line do Orcad, Orcad Inc.

**Access Conditions and Attendance Excuse**

Realization and approval in the distributed evaluation component.
Frequency of at least 80% of classes.

**Conditions for Exam Admission**

Discipline without final exam.
Worker-student students (and legal equivalents) who have not attended the course unit due to hourly incompatibility can do the work related to the evaluation distributed on the day scheduled for exam.

**Evaluation Method**

The final grade is composed by the sum of two installments:
Distributed evaluation (50%) + Practical Work (50%).
- Distributed evaluation component: evaluation throughout the classes taking into account aspects such as performance / interest and application in class work;
-Practical Work: Individual work to be done in classes or extra-classes and that deal with the tools addressed

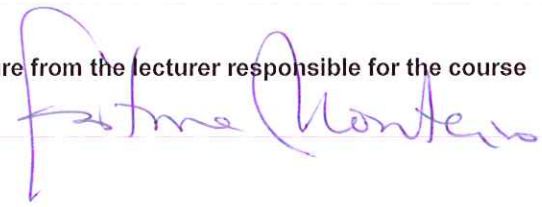
**Conditions for Results Improvement**

Completion of new Practical Work, within a defined period, subject to discussion, as well as repetition of the work of the distributed component of the evaluation.

**Date**

**12/09/18**

**Signature from the lecturer responsible for the course**



Instituto Superior de Engenharia de Coimbra
www.isec.pt

Lecturer's signature: _____

**Licenciatura em Engenharia Electrotécnica – 9109** (Português)

**BsC in Electrical Engineering – 9109** (Inglês)

Academic Year: **2018 / 2019**

## *Program Contents*

**Course Unit** ELECTRICAL CIRCUITS THEORY I

**Specialization (s)** ELECTRICAL ENGINEERING

**Subject type** Basic Sciences **Research Area** Electrical Engineering

**Year** 1º **Semester** 1º **ECTS** 5,5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 1 | 14 |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | **143** |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 35 |
| Works / Group Works | 36 |
| Project | |
| Evaluation | 2 |
| Additional | |

**Lecturer** **Manuel Travassos Valdez.**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Manuel Travassos Valdez | PhD | Prof. Adjunto |
| Theoretical-Practical Lectures | Manuel Travassos Valdez | PhD | Prof. Adjunto |
| Practical-Laboratoty Lectures | Paulo Filipe Tavares | PhD | Prof. Adjunto |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Manuel Travassos Valdez

**Goals**

The objective of curricular unit I is
- to impart the principles and basic concepts of Circuit Analysis concepts for DC circuits and single-phase AC circuits.
-to understand/learn the significance of resolution electrical circuits in circuit analysis.
-to understand/learn the theory and functioning DC circuits.
-to understand/learn the theory and functioning of single-phase AC circuits.

**Skills**

- Definition of basic electrical quantities and associated units.
- Understanding the relationship between charges, current, voltage, and power.
- Ability to work with the passive sign convention.
- Introduction to dependent and independent voltage and current sources.
- Detailed knowledge of the behaviour of the resistor and Ohm's law.

- Understanding of the distinction between nodes, paths, loops, and branches.
- Ability to employ Kirchhoff's current law (KCL).
- Ability to employ Kirchhoff's voltage law (KVL).
- Skills in analysing simple series and parallel circuits.
- Ability to simplify series and parallel-connected sources.
- Competence at reducing series and parallel resistor combinations.
- Intuitive understanding of voltage and current division.

- Implementation of nodal analysis.
- Implementation of mesh analysis.
- Use of supernodes and supermeshes.
- Ability to choose between nodal and mesh analysis.

- Using superposition to identify individual contributions to a total response.
- Using source transformations to reduce the complexity of a circuit.
- Determining the Thévenin equivalent of any network.
- Determining the Norton equivalent of any network.
- Computing the load resistance that will result in maximum power transfer.

-Developing a familiarity with sinusoidal functions.
-Understanding the concepts of impedance and admittance.
-Learning how to use phasors to determine the forced response of a circuit subjected to sinusoidal excitation.
-Applying mesh analysis, nodal analysis, superposition, source transformations, and Thévenin's theorem using phasors.

-Determining the instantaneous power delivered to an element.
-Defining the average power supplied by a sinusoidal source.
-Calculating the rms value of a time-varying waveform.
-Using complex power to identify average and reactive power.
-Identifying the power factor of a given load, and learning means of improving it.
-Understanding mutual and self-inductance.

- Understanding the significance of resolution electrical circuits in circuit analysis.
- Understanding the theory and functioning DC circuits.
- Understanding the theory and functioning of single-phase AC circuits.

**Program Contents**

Basic Components and Electric Circuits
Units and Scales. Charge, Current, Voltage, and Power. Voltage and Current Sources. Ohm's Law.
Voltage and Current Laws
Nodes, Paths, Loops, and Branches. Kirchhoff's Current Law. Kirchhoff's Voltage Law. The Single-Loop Circuit. The Single Node-Pair Circuit. Series and Parallel Connected Independent Sources. Resistors in Series and Parallel. Voltage and Current Division.
Basic Nodal and Mesh Analysis
Nodal Analysis. The Supernode. Mesh Analysis. The Supermesh. Nodal vs. Mesh Analysis: A Comparison. Computer-Aided Circuit Analysis.
Useful Circuit Analysis Techniques
Linearity and Superposition. Source Transformations. Thévenin and Norton Equivalent Circuits. Maximum Power Transfer. Selecting an Approach: A Comparison of Various Techniques.
Sinusoidal Steady-State Analysis
Characteristics of Sinusoids. Forced Response to Sinusoidal Functions. The Complex Forcing

Function. The Phasor. Phasor Relationships for R, L, and C. Impedance. Admittance. Nodal and Mesh Analysis. Superposition, Source Transformations, and Thévenin's Theorem. Phasor Diagrams.
AC Circuit Power Analysis
Instantaneous Power. Average Power. Effective Values of Current and Voltage. Apparent Power and Power Factor. Complex Power. Comparison of Power Terminology. Physical significance of powers. Power factor correction. Introduction to metrology: measurement methods and associated errors, measuring instruments and their specifications. Use and familiarization with bench equipment (voltage sources, function generator, Digital Multimeters and analog voltmeters and ammeters). Principle of operation and use of the oscilloscope.
Magnetically Coupled Circuits
Mutual Inductance. Energy Considerations. The Linear Transformer. The Ideal Transformer.

**Bibliography**

- A. H. ROBBINS AND W.C. MILLER, "Circuits Analysis: Theory and Practice", 3rd Edition, Clifton Park, NY, Thomson, Delmar Learning, 2004.

- A. M. DAVIS, "Some Fundamental Topics in Introductory Circuit Analysis: A Critique", IEEE Transactions on Education, Vol. 43, No. 3, August 2000.

- C. K. ALEXANDER, M. SADIKU, "Fundamentals of Electric Circuits", NY, McGraw Hill Science/Engineering/Math, 3rd Edition, 2006.

- E. HUGHES AND I. MCKENZIE-SMITH, Electric and Electronic Technology, Prentice Hall, 2002.

- EDMINISTER J. A., "Circuitos Eléctricos", Schaum Ed., Mc- Graw-Hill, 3rd, Rotating Electrical Machinery, Indiana, USA, 1990.

- EDWARD HUGHES, "Electric and Electronic Technology", Prentice Hall, 2002.

- M. GUSSOW, Schaum's Outline of Basic Electricity, McGraw-Hill Publishing Co., NY, 2nd Edition, 2007.

- T. L. FLOYD, Principles of Electric Circuits, Prentice Hall, 7th Edition, 2003.

- THOMAS L. FLOYD, "Principles of Electric Circuits", Prentice Hall, 7th Edition, 2003.

Available support materials:-

> problems/exercises sheets

> practical work worksheets

> Laboratory work support material

**Access Conditions and Attendance Excuse**

**Conditions for Exam Admission**

Students who have obtained the minimum value required in the laboratories have access to the exam.

**Evaluation Method**

The student must take a written test, not having a grade lower than 8 points. The written exam is quoted for 20 values (0-20).
The final mean of the test with the final grade of the laboratory component should be equal to or greater than 9.5 values.

**Conditions for Results Improvement**

In accordance with the regulations in force at the Higher Institute of Engineering of Coimbra

| Date | Signature from the lecturer responsible for the course |
|---|---|
| 15 September, 2018 |  |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: Verónica Vasconcelos

**Licenciatura – BsC Engenharia Electrotécnica** (Português)

**Licenciatura – BsC - Electrical Engineering** (Inglês)

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** INTRODUCTION TO PROGRAMMING

**Specialization (s)** BASIC SCIENCE

**Subject type** Mandatory **Research Area** Electrical Engineering

**Year** 1st **Semester** 1st **ECTS** 5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratory Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 130 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 57 |
| Works / Group Works | 15 |
| Project | |
| Evaluation | 2 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Verónica Vasconcelos | PhD | Prof. Adjunto |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratory Lectures | Adelino Pereira | PhD | Prof. Adjunto |
| Practical-Laboratory Lectures | Verónica Vasconcelos | PhD | Prof. Adjunto |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Verónica Vasconcelos

**Goals**

Acquire the indispensable algorithmic structures and programming techniques / tools to solve, write, debug and test, small applications using the C programming language.

**Skills**

Know and understand the main algorithmic techniques;
Develop the capacity of abstraction and logical, essential to problem solving;
Know and understand the basic of computer programming;
Develop small applications in C language.

**Program Contents**

Basic computer architecture; Programming developing cycle; Algorithms and Modeling issues; Basic C programming language concepts; Structure of a program; Primitive data types, variables, constants and elementary operators; Input and output functions; Control structures; Structured programming: functions; Pointers; Arrays: one dimension and

multidimensional, strings.

**Bibliography**

K. N. King, "C Programming – A Modern Approach", Norton & Company, 2nd Ed., 2008

Herbert Schildt, "Teach Yourself C", McGraw-Hill, 3rd Ed, 1998

**Access Conditions and Attendance Excuse**

Those provided by law.

**Conditions for Exam Admission**

Have obtained a minimum of 1.5 / 4 values in the project.

Maximum of two absences in practical-laboratory lectures.

*The conditions of access are valid for all periods of examination*

**Evaluation Method**

Final written exam (16 values);
Two laboratory tests (4 values).
Expected dates of the laboratory tests:
* 1st test - 12 to 13 November 2018;
* 2nd test - 17 to 21 December 2018.

**Conditions for Results Improvement**

It is only possible to improve the component evaluated by exam, in accordance with the regulations of ISEC.

| Date | Signature from the lecturer responsible for the course |
|---|---|
| 17-9-2018 | Jerónimo Nascimento |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: MPMacedo

**Licenciatura – BSc Engenharia Electrotécnica – Diurno**

**Licenciatura – BSc Electrotecnical Engineering – Daytime**

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** GENERAL PHYSICS

**Specialization (s)**

**Subject type** **Research Area** Physics

**Year** 1 **Semester** 1 **ECTS** 4,5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 1 | 14 |
| Theoretical-Practical Lectures | 1 | 14 |
| Practical-Laboratoty Lectures | 1 | 14 |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 117 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 58 |
| Works / Group Works | 14 |
| Project | |
| Evaluation | 3 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Milton Augusto Morais Sarmento Pato de Macedo | PhD | Adjunct Professor |
| Theoretical-Practical Lectures | Milton Augusto Morais Sarmento Pato de Macedo | PhD | Adjunct Professor |
| Practical-Laboratory Lectures | Victor José Dias de Almeida Magalhães | MSc | Adjunct Professor |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Milton Augusto Morais Sarmento Pato de Macedo

**Goals**

Understanding of Nature in physics domain is an important skill enlarged in this curricular unit. Theoretical knowledge is consolidated with laboratory works.

**Skills**

Theoretical knowledge is consolidated with laboratory works.
Comprehension abilities in physics domain are developed based on secondary school knowledge and on appropriate and up to date books of international authors.
A professional attitude in his relation to work is developed in laboratory experiments.
Ability to perform scientific decisions and judgments associated both with the theoretical and practical knowledge acquired.
Interchanging of ideas and the discussion of problems and solutions is promoted during laboratory experiments.
Self-knowledge acquisition habits are developed.

**Program Contents**

1. Systems of Units: The International System of Units; Dimensional equations; Conversion of units
2. Vectors: Scalars and vectors; Vector addition; Components and unit vectors; Scalar product; Vector product.
3. Kinematics: Average and instantaneous velocity; acceleration; motion in a straight line; circular motion; projectile motion
4. Dynamics: Newton's Laws; Weight and linear momentum; Inertial and friction forces; Torque; Couple; Angular momentum of a particle and of a rigid body; Moments of inertia; Rotational dynamics of a rigid body
5. Work and Energy: Work done by a constant and variable force; Power; Kinetic energy of a particle and rotational and translational kinetic energy of a rigid body; Conservative forces; Potential energy; Conservation of mechanical energy; Dissipative forces
6. Oscillations: Simple harmonic motion (SHM); The block – spring system; Energy in SHM; Pendulum; Superposition of SHM
7. Heat Transfer: Heat Conduction; Heat transfer by Convection; Radiation

**Bibliography**


- Tipler, *Física para cientistas e engenheiros*, LTC - Livros técnicos e científicos, 4ª Edição
- Tipler, *Física para cientistas e engenheiros*, Vol. 1 e 2, Editora Guanabara Koogan S.A., 3ª Edição
- Frederick J. Bueche, Eugene Hecht, *Física*, Mc-Graw Hill Portugal
- Serway, *Física*, Vol. 2, LTC - Livros técnicos e científicos
- H. Moyses Nussenzveig, *Curso de Física Básica*, Vol. 2, Editora Edgard Blücher, 3ª Edição
- Marcelo Alonso, Edward J. Finn, *Física*, Addison-Wesley Iberoamericana Espanha
- Marcelo Alonso, Edward J. Finn, *Física - um curso universitário*, Vol. 1 e 2, Editora Edgard Blücher (Portuguese version)
- Robert Resnick, David Halliday, *Física*, Livros Técnicos e Científicos, Vol. 1 e 2, 4ª Edição
- Francis Sears, Mark W. Zemansky, Hugh D. Young, *Física*, Vol. 1 e 2, Livros técnicos e científicos, 2ª Edição
- Milton Macedo, *Theoretical texts*, ISEC
- Miguel Couceiro, Milton Macedo e Susete Fetal, E*xercises and practical examples*, ISEC
- B. N. Taylor, Guide for the Use of the International System of Units (SI), NIST Special Publication 811, 1995 Edition
- B. N. Taylor and C. E. Kuyatt, Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results, NIST Technical Note 1297, 1994 Edition


**Access Conditions and Attendance Excuse**

Students covered by the status of worker-student (Lei nº7/2009, Lei nº105/2009 e Lei nº 35/2014), in case it is impossible for them to attend laboratorial classes, it must be achieved an agreement between the responsible lecturer and the student, by action of the student in the two initial weeks of the semester, an other schedule for the laboratorial component.

**Conditions for Exam Admission**

A minimum mark of 2/4 in laboratory component of evaluation is demanded to be admitted for final exam.

**Evaluation Method**

A kind of continuous (distributed) evaluation is optional. It consists on three tests (T) during the semester and a minimum of 75% assiduity is demanded. Also approval in Practical works (P) is mandatory (minimum of 2 points). The three tests are worth: T1 and T3 - 4 points and T2 - 8 points. It is also mandatory a minimum mark of 1,5 in tests T1 and T3 and a minimum mark of 3,5 for test T2. Accomplishing these several criteria the final mark is T+P, where T is worth 16 points and P 4 points. The approval requires that the mark P is greater than or equal to 2 points and T+P greater than or equal 9,5. There is also the option to perform Final Exam (E). In a similar manner the final mark is E+P, where E is worth 16 points and P 4 points. The approval requires that the mark P is greater than or equal to 2 points.

**Conditions for Results Improvement**

In accordance with current laws in ISEC.

**Date**

**17/9/2018**

**Signature from the lecturer responsible for the course**

Milton Paiva de Macedo

**Course Unit** LINEAR ALGEBRA

**Specialization (s)** LINEAR ALGEBRA

**Subject type** Basic Science **Research Area** Mathematics

**Year** 1 **Semester** 1 **ECTS** 5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 2 | 28 |
| Practical-Laboratoty Lectures | | |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 134h30 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 76 |
| Works / Group Works | |
| Project | |
| Evaluation | 2h30 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Carla Fidalgo | PhD | Adj. Professor |
| Theoretical-Practical Lectures | Carla Fidalgo | PhD | Adj. Professor |
| Practical-Laboratoty Lectures | | | |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Carla Fidalgo

## Goals

- Perform basic matrix operations.
- Compute matrix determinants, eigenvalues and eigenvectors.
- Understand and apply concepts related to vector spaces.
- Solve and interpret linear systems using matrix theory.
- Understand the importance of linear algebra and analytic geometry in engineering.
- Recognize the importance of the algorithms in linear algebra.

## Skills

- Develop algorithms using a logical and structured reasoning.
- Base problem solving on mathematics.
- Compare, with criticism, the results obtained by analytical means with the ones obtained by computational means.
- Select appropriately the accessible information (from monographs, textbooks, web, ...).
- Expose, using documents, the problems' solution in a clear and simple way.
- Explain the concepts and problems' solution in an appropriated way.
- Solve practical problems with autonomy using, not only the subjects treated in the class, but also other related topics.

## Program Contents

1. **Matrices and Linear Systems**
Introduction; Matrix operations and their properties; Row echelon form and rank; Classification and geometry of linear systems; Gaussian elimination; Homogeneous systems; Matrix inversion: Gauss-Jordan method;
2. **Determinants**
Definition and properties; Cramer's rule.
3. **Linear Spaces**
Definition, Examples and Properties; Subspaces; Linear combinations; Linear expansion; Linear independence; Basis and dimension.
4. **Eigenvalues**
Eigenvalues, eigenvectors and their properties; Diagonalization; Cayley-Hamilton Theorem.

## Bibliography


o ANTON, H. - *Elementary Linear Algebra*, John Wiley & Sons, Inc, 2000.

o CABRAL, I., PERDIGÃO, C. and SANTIAGO, C., *Álgebra Linear – Teoria, Exercícios resolvidos e Exercícios propostos com soluções*, Escolar Editora, 2009.

o CARREIRA, A. and PINTO, G. – *Cálculo Matricial – Teoria Elementar*, Ciência e Técnica, 1999.

o FIDALGO, C. - *Álgebra Linear*, Instituto Superior de Engenharia de Coimbra.

o GRAHAM, A. - *Matrix Theory and Applications for Engineers*, Ellis Horwood Limited, 1979.

o JAMES, G. - *Modern Engineering Mathematics*, Prentice Hall, 2000.

o KREYSZIG, E., Advanced Engineering Mathematics (8th Ed.), Wiley.

o PINTO, G.; MONTEIRO, A.; MARQUES, C. – *Álgebra Linear e Geometria Analítica. Problemas e Exercícios*, McGraw-Hill, 2001. ISBN-13: 9789728298661.

o NICHOLSON, W. – *Elementary Linear Algebra with Applications*, PWS Publishing Company, 1986. ISBN-13: 9780871509024.

o SANTANA, A.; QUEIRÓ, J. – Introdução à Álgebra Linear, Gradiva, 2010. ISBN 9789896163723

**Access Conditions and Attendance Excuse**
Not applicable

**Conditions for Exam Admission**

All students enrolled in accordance with the ISEC's rules may take the exam.

**Evaluation Method**

Final Exam: 100%
The approval requires the acquisition of at least 9.5 values and the marks above 17 are subject to an oral exam.

**Conditions for Results Improvement**

According to the rules defined by ISEC

| Date | Signature from the lecturer responsible for the course |
| --- | --- |
| 12/09/2018 |  |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:

**Licenciatura – BsC Engenharia Eçletrotécnica - *9109***

**Licenciatura – BsC Electrical Engineering**

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** CALCULUS I

**Specialization (s)**

**Subject type** Basic Sciences **Research Area** Mathematic

**Year** 1º **Semester** 1º **ECTS** 6

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 2 | 28 |
| Practical-Laboratoty Lectures | 0 | 0 |
| Tutorial Orientation | 1 | 14 |
| Project | 0 | 0 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 58 |
| Works / Group Works | 20 |
| Project | 0 |
| Evaluation | 8 |
| Additional | 0 |

**Total of Working Hours** 156

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Cristina M. Ribeiro Martins Pereira Caridade | PhD | Adjunct Professor |
| Theoretical-Practical Lectures | Cristina M. Ribeiro Martins Pereira Caridade | PhD | Adjunct Professor |
| | Pascoal Martins Silva | PhD | Adjunct Professor |
| Practical-Laboratoty Lectures | | | |
| Tutorial Orientation | Cristina M. Ribeiro Martins Pereira Caridade | PhD | Adjunct Professor |
| | Pascoal Martins Silva | PhD | Adjunct Professor |
| Project | | | |

**Responsible(s) Lecturer (s)** Cristina M. Ribeiro Martins Pereira Caridade

**Goals**

The teaching of mathematics in general should facilitate mathematical communication, reflective thinking, the application of mathematical techniques to solve problems, the critical analysis of the results obtained, and interdisciplinary. One of the teaching objectives of Mathematical Analysis of the 1st year is to provide the basic fundamentals of mathematical methods, usually applied in the areas of Engineering, used by the various disciplines of the Degree in Electrical Engineering.

**Skills**

It is intended that students develop algebraic manipulation skills and independent and analytical reasoning and the ability to apply mathematical concepts in solving practical problems.

Signature of Teacher:

**Program Contents**

Theory of Errors
- Absolute Error and Relative Error.
- Truncation errors.
- Taylor's theorem with the Lagrange form of the remainder.
- Approximation of functions by the Taylor Polynomial.

Nonlinear Equations
- Method of Bisection.
- Newton Method.
- Convergence criterion for Newton's method.
- Polynomial zeros.
- Location of zeros.
- Newton's method for algebraic equations.

Elementary Functions
- Exponential function
- Logarithmic function
- Hyperbolic functions
- Inverse Trigonometry functions

Differential calculation
- Limits and continuity.
- Derivative and its geometric interpretation.
- Theorems of Rolle, Lagrange and Cauchy. Cauchy's Rule.
- Derivative of inverse function and composite function.
- Derivative Rules.
- Successive Differentiation
- Differential of a function.
- Linear Approach.
- Implicit Differentiation.

Integration
- Definition and properties.
- Basic Integrals.
- Integration technics.

Integral Calculus
- Definitions and properties.
- The fundamental theorems of calculus.
- Applications of definite integral
  - Calculation of areas, volumes and lengths of arcs.
  - Numerical Integration.
- Newton-Cotes formulas
  - Rule of trapezoids.
  - Simpson's Rule.
- Indefinite Integral.
- Improper integral.
- Application of Integral Calculus to solve some problems usually associated to the Electrical Engineering.

**Bibliography**


- Cristina M.R. Caridade, Apontamentos das aulas, DFM, ISEC, 2018.
- Cristina M.R. Caridade, Slides das aulas, DFM, ISEC, 2018.
- e-MAIO (Módulos de Aprendizagem Interativa online) - https://dfmoodle.isec.pt/
- Moodle ISEC -Análise Matemática I - http://moodle.isec.pt/
- J. Stewart, Cálculo, Vol.I, 4ª ed. Pioneira, Thomson Learning, 2001.
- A. Howard, Cálculo: um novo horizonte, 6 ª ed., Porto Alegre, Bookman, 2000.
- R. Larson, R. P. Hostetler, B. H. Edwards, Cálculo, Vol. I, 8ª ed., McGraw Hill, 2006.
- Pré-Cálculo e Introdução ao Cálculo, Departamento de Física e Matemática, Secção de texto do ISEC
- E. W. Swokowsky, Cálculo com Geometria Analítica, Vol. 1, 2ª ed., Rio de Janeiro Makron Books, cop. 1995.
- M. A. Saraiva, M. A. Silva, Primitivação, Edições Asa, 1993.
- B. Demidovitch, Problemas e Exercícios de Análise Matemática, McGraw-Hill, 1993.


**Access Conditions and Attendance Excuse**

Not Applicable.

Signature of Teacher: 

**Conditions for Exam Admission**
All students enrolled in this course have access to the first and second exam call.

**Evaluation Method**
At the beginning of the semester, students will opt for a distributed evaluation, where they will use the e-MAIO platform (Interactive Learning Modules online) or a final exam evaluation.

The distributed evaluation will be done through two tests and a practical work distributed as follows:

| | 1st Test | | 2nd Test | | Practical work |
|---|---|---|---|---|---|
| | TPL | TO | TPL | TO | |
| **Marks** | 6 | 2 | 6 | 2 | 4 |
| **Minimum** | 2,5 | 0,75 | 2,5 | 0,75 | No minima |
| **Date** | TP1 - November 20<br>TP2 - November 19<br>(during practical classes) | | Date of first examination | | **Submit:** until 12/31/2018<br>**Presentation:** exam support week. |

Theoretical-Practical Lectures (TPL); Tutorial Orientation (TO)

If the student does not obtain the minimums in any of the tests, or the sum of the marks obtained in the two tests and in the practical work, is less than 9.5 values, the student will have to make the second examination call. The second exam call will be 20 values and the student will have to obtain a mark of 9.5 or higher.

In the Final exam evaluation, students will not have to do the practical work. For these students the first and second examination call will be 20 values (4 TO and 16 TPL). The student who has already obtained minimums (distributed evaluation) in the TO part or in the TPL part can only do one of the parts (TPL or TO) under examination. The student must obtain a mark of 9.5 or higher.

**Conditions for Results Improvement**
The conditions of results improvement are those that are forecast in the "Regulation of Evaluation of Knowledge and Transition of Year" (REACTA).

**Date** | **Signature from the lecturer responsible for the course**

September 11, 2018 

Signature of Teacher: .....

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

**Licenciatura – BSc em Engenharia Eletrotécnica - 9109**

**Licenciatura – BSc in Electrical Engineering - 9109**

Academic Year: 2018 / 2019

***Program Contents***

**Course Unit** ELECTRONICS AND TELECOMMUNICATIONS PROJECT - 910996
**Specialization (s)** ELECTRONICS AND TELECOMMUNICATIONS

**Subject type** Specialisation Sciences **Research Area** Electrical Engineering

**Year** 3 **Semester** 2 **ECTS** 7

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | | |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | 2 | 28 |
| Project | | |
| **Total of Working Hours** | | 182 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | |
| Works / Group Works | |
| Project | 123 |
| Evaluation | 3 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | | | |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratoty Lectures | Fernando José Pimentel Lopes | PhD | Prof. Coordenador |
| Tutorial Orientation | Fernando José Pimentel Lopes | PhD | Prof. Coordenador |
| Project | | | |

**Responsible Lecturer** Fernando José Pimentel Lopes

**Goals**
The objective of the Electronic and Telecommunications Project Curricular Unit is to involve the students in a project team to develop and test a system with a specific function, using concepts and technologies in the area of Electronics and Telecommunications. Upon completing this curricular unit, students must demonstrate autonomy in the identification and analysis of problems, in the proposal, implementation and testing of specific solutions. The project typically includes hardware components, software, a demonstration test and the preparation of a detailed report. It also includes a public presentation, the elaboration of a Poster and, as an objective to be fulfilled whenever considered appropriate, a scientific publication.

**Skills**
Ability to select technical solutions in the field of Electronics and Telecommunications Systems and to be able to present them to the supervisor, the employer or client.
Design, execute and maintain the proposed solutions.

Signature of Teacher:

## Program Contents

Analysis of requirements for each problem.
Analyze the different possible options for its resolution.
Design the system as well as prepare the procedures for testing and validation.
Implement a prototype of the projected system.
Perform the test and validation of the implemented system.
Implement the final solution.
Document all phases of the project.
Carry out control and management of the project.
Prepare a final report and, when appropriate, a poster in A0 format.

## Bibliography

[1] Specific bibliography for each project indicated by the supervisors.

[2] Bibliography of the Curricular Units of the Electronics and Telecommunications Branch

[3] Selected Hardware Datasheets and Application Notes

[4] Manuals for the needed Software Tools

## Access Conditions and Attendance Excuse

For students under the of Worker-Student Statute, and for components with compulsory attendance and distributed evaluation, it may be agreed between the teacher responsible for the course and the student, on his / her own initiative, adjustments to the functioning of these components.
In this case, during the first two weeks of teaching, students should indicate to the teacher their status as student-worker, establishing immediately how to adjust the functioning of the referred components. The presentation of the employer's work timetable or other relevant information may be required.

## Conditions for Exam Admission

**Not applicable.**

## Evaluation Method

Presentation of the project, demonstration of the prototype, and production of the respective final report.
Presentation and public exam on the work.
Production of A0 Poster when appropriate.

## Conditions for Results Improvement

In accordance with the regulations and legislation.

| Date | Signature from the lecturer responsible for the course |
|---|---|
| 21/01/2019 | |

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Signature of Teacher: _____

**Licenciatura em Engenharia Electrotécnica – 9109** (Português)

**BsC in Electrical Engineering – 9109** (Inglês)

Academic Year: _2018_/_2019_

## Program Contents

**Course Unit** PROPAGATION AND ANTENNAS

**Specialization (s)** ELECTRONICS AND TELECOMMUNICATIONS

**Subject type** Specialization Sciences **Research Area** Electrical Engineering

**Year** 3rd **Semester** 2nd **ECTS** 5.5

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | 2 | 28 |
| Practical-Laboratory Lectures | | |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 143 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 50 |
| Works / Group Works | 34 |
| Project | |
| Evaluation | 3 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Victor Daniel Neto dos Santos | PhD | Assistant Prof. |
| Theoretical-Practical Lectures | Victor Daniel Neto dos Santos | PhD | Assistant Prof. |
| Practical-Laboratory Lectures | | | |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Victor Daniel Neto dos Santos

### Goals

This curricular unit provides the fundamental concepts to understand the propagation mechanisms and problems associated to transmission lines (guided propagation) and antennas. Students should be able to analyze and design transmission lines and antennas for real transmission system. Moreover, students should be able to compute the radiation pattern, gain, input impedance and other relevant parameters of antennas for specific applications in VHF; UHF and microwave bands.

### Skills

- Know and understand the main features of a transmission line;
- Know how to apply the Smith chart to solve problems associated with transmission lines;
- Know, understand and apply the main impedances matching networks;
- Know and understand the main parameters of different types of antennas including the radiation pattern;
- Understand the theory and operation of some antennas such as linear antennas, reflectors and antennas arrays.

Signature of Teacher: Dante

**Program Contents**

Introduction
- "Propagation and Antennas" unit motivation;
- Electromagnetic waves propagation in transmission lines and in free space;
- Maxwell's Equations.

Transmission Line Theory
- Two-wire transmission line; coaxial cable; microstrip line, etc.;
- Telegrapher equation; characteristic impedance; propagation constant;
- Terminated transmission line; reflection coefficient; input impedance; VSWR; transients;

The Smith Chart
- Origin and graphical representation;
- The impedance and admittance Smith charts;
- Practical applications of the Smith chart:
  - Reflection coefficients; VSWR; RL; impedance and admittance representation;
  - Constant VSWR circles representation;
  - Standing wave maximums and minimums location;
  - Impedance matching problems resolution.

Impedance Matching
- Benefits of impedance matching;
- Impedance transformation;
- Lumped and distributed matching networks; stubs; λ/4 transformer.

Antenna Basics
- Antennas in radio communications systems:
  - Radio and TV broadcast; cellular systems; WLAN; microwave links; satellite communications;
- Radiation Mechanism;
  - Near field (Fresnel) and far field (Fraunhofer);
- Fundamental parameters:
  - Radiation pattern in polar and Cartesian coordinates (main lobe, side lobe; HPBW; FNBW; etc.);
  - Directivity; gain; effective area; efficiency;
  - Bandwidth; polarization; input Impedance; etc.

Wire Antennas
- Dipoles: infinitesimal dipole; short dipole; λ/2 dipole; folded dipole, etc.
- Monopoles and image theory, helical antennas,

Antennas Analysis and Design
- Antenna Arrays theory;
- Isotropic linear arrays; pattern multiplication principle;
- Reflectors: planar; corner e parabolic dishes;
- Microstrip Antennas; Aperture Antennas and others.

**Bibliography**


- C. A. Balanis, "Antenna Theory: Analysis and Design", 4th edition, John Wiley & Sons, 20016.
- Huang Y., Boyle K., "Antennas: From Theory to Practice", John Wiley & Sons Ltd, August 2008.
- J. D. Kraus and R. J. Marhefka, "Antennas for all Application", 3rd edition, McGraw-Hill, 2003.
- Collin, Robert E.; "Antennas and Radiowave Propagation", McGraw-Hill, Inc., 1985.
- S.R. Saunders, A. Aragón-Zavala "Antennas and propagation for wireless communication systems", 2nd edition, John Wiley & Sons, 2007.
- C.W. Davidson "Transmission Lines for Communications." MacMillan Press, London, 1978.

Signature of Teacher:_____

**Access Conditions and Attendance Excuse**

For students with "worker-student" status, by virtue of law No. 105/2009, of law No. 7/2009, and other applicable regulation, and for components with compulsive attendance and distributed evaluation, should be agreed between the responsible lecturer for the course unit and the student, on his own initiative and at the beginning of the academic semester, a form of alternative operation of these components. The presentation of the employer's work schedule or other relevant information must be required.

**Conditions for Exam Admission**

Have attended the laboratory classes (up two non justified fouls) and have held and defended with approval the laboratory reports. Moreover, those provided for in regulation "Regulamento de Avaliação de Conhecimentos e Transição de Ano" (Law n.º528.2017).

**Evaluation Method**

FG (Final Grade) = 0,7 x ExamG (written Exam Grade) + 0,3 x LabG (Lab Grade)

To obtain Approval in the "Propagation and Antennas" unit it is necessary to attain a Final Grade grater or equal to 9.5 values (FG >= 9.5), being mandatory to obtain, in addition, at least 9.0 values in the final written exam (ExamG > 9.0) graded in a 20 values scale.

The Lab Grade will be based on the laboratorial reports; classroom participation and laboratorial skills.

**Conditions for Results Improvement**

The listed in article 23 of the regulation "Regulamento de Avaliação de Conhecimentos e Transição de Ano", (Law n.º 528.2017) republished in the Official Journal (Diário da República), 2.nd Series, n.º 22; January 31th of 2018".

| **Date** | **Signature from the lecturer responsible for the course** |
|---|---|
| **2019/01/21** | Victor D. N. Santos |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

**Licenciatura em Engenharia Eletrotécnica**

**BSc in Electrical Engineering**

Academic Year: **2018/2019**

***Program Contents***

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**Course Unit** LOCAL AND INDUSTRIAL NETWORKS

**Specialization (s)**

**Subject type** **Research Area** Electrical Engineering

**Year** 3 **Semester** 2 **ECTS** 6

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 74 |
| Works / Group Works | 24 |
| Project | |
| Evaluation | 2 |
| Additional | |

**Total of Working Hours** 156

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | João Carlos Ramos Perdigoto | MSc | Invited Professor |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratoty Lectures | João Carlos Ramos Perdigoto | MSc | Invited Professor |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** João Carlos Ramos Perdigoto

**Goals**

To provide the necessary knowledge and training in local area and industrial networks.

**Skills**

To know and understand the technologies available in the market.
To choose, design, implement and maintain industrial communication systems, using equipment available in the market.
To choose, design, implement and maintain local area networks, using equipment available in the market.
To install and maintain local networks and communications systems at factory level and at services facilities.
To understand and perform diagnostic in communication networks and at industrial sites.
To design, implement and maintain the communication part of automation and robotic systems.

Signature of Teacher: 

**Program Contents**

Serial and parallel communication interfaces
Local Area Networks:
- Architectures and Topologies: Bus (bus); Ring, Star, Mesh.
- Ethernet (IEEE 802.3), Token Ring (IEEE 802.5), FDDI, Token-Bus
- Wireless LANs: IEEE 802.11, Bluetooth, ZigBee;
- Network Equipment: HUB, Switch, Router.
- The OSI Model
- The TCP / IP: Internet Protocol, Internet Control Message Protocol (ICMP), TCP, UDP protocol
- TCP / IP Services
- Network Applications
- Internet

Industrial Networks:
- The Production Process
- Use of Networks in Industrial Environment
- Requirements for Industrial Networks
- Networks of sensors and actuators
- Transmission Media
- Architectures and protocols:
- Architecture MAP / TOP
- fieldbus
- CAN and DeviceNet
- Modbus
- Profibus
- ISA SP-50
- Industrial Ethernet

Network Equipment
Applications

**Bibliography**

E. Monteiro, F. Boavida, "Engenharia de redes informáticas", FCA - Editora de Informática
Lammle, Todd, "CCNA Cisco certified network associate: study guide", Sybex,
Spurgeon, C., "Ethernet: the definitive guide", O´Reilly,
Geier, Jim, "Wireless Lans: implementing interoperable networks", MacMillan,
Lawrenz, W., "CAN System Engineering", Springer,
N. P. Mahalik, [editor] ,"Fieldbus technology : industrial network standards for real-time distriduted control", Springer

Signature of Teacher:_____

## Access Conditions and Attendance Excuse

In accordance with the academic regulations and applicable laws.

### Conditions for Exam Admission

All lab works must have been executed with no more than 2 lab works not attended.

### Evaluation Method

Laboratory experiments, small projects and monography – 5 values.
Monography must be delivered until 17th May 2019.
Final Exam – 15 values
Under less than 40% at any of the previous items student will not pass.
Grade Scale (0 to 20).
Final grade must be upper than 9.5 in order to pass.

### Conditions for Results Improvement

In accordance with the academic regulations and applicable laws.

**Date**

**19 / Jan / 2019**

**Signature from the lecturer responsible for the course**

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

**Licenciatura em Engenharia Eletrotécnica**

**BSc in Electrical Engineering**

Academic Year: **2018 / 2019**

## Program Contents

**Course Unit** TELECOMMUNICATION SYSTEMS

**Specialization (s)** ELECTRONICS AND TELECOMMUNICATION

**Subject type** **Research Area** Electrical Engineering

**Year** 3rd **Semester** 2nd **ECTS** 6

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 57 |
| Works / Group Works | 40 |
| Project | |
| Evaluation | 3 |
| Additional | |

**Total of Working Hours** 156

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Frederico Miguel do Céu Marques dos Santos | PhD | Adjunct Professor |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratoty Lectures | Frederico Miguel do Céu Marques dos Santos | PhD | Adjunct Professor |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Frederico Miguel do Céu Marques dos Santos

**Goals**

It is intended to introduce a broad set of concepts and technologies of communication and telecommunications systems. It will address aspects that provide an integrated view of these different technologies in order to ensure the qualitative interpretation and correct and comprehensive planning of telecommunications systems.

**Skills**

To know and understand:

- Telecommunication systems and services;
- Telephone communication systems;
- Broadband communication systems;
- Optical communications systems;
- Data networks and the Internet;
- Telecommunication services.

**Program Contents**

Introduction to telecommunication systems and services;
Telephone communication systems;
Broadband communication systems;
Optical communication systems;
Data and Internet networks;
Telecommunication services

Signature of Teacher:_____

**Bibliography**

Carlson, B., Crilly, P., Rutledge, J.: Communication Systems: An introduction to Signals and Noise in Electrical Communication, 4th Ed., McGraw-Hill, 2002. ISBN: 9780071121750
Haykin, S., Moher, M.: An Introduction to Digital and Analog Communications, 2nd Ed, John Wiley & Sons, 2006. ISBN: 9780471432227
Stallings, W.: Data and Computer Communications, 8th Ed, Pearson Prentice Hall, 2007. ISBN: 9780132433105
Senior, J.: Optical Fiber Communications: Principles and Practice, 3rd Ed, Pearson Prentice Hall, 2009. ISBN: 9780130326812
Keiser, G.: Optical Fiber Communications, 4th Ed, McGraw Hill Education, 2011. ISBN: 9780073380717
Dood, A.: The Essential Guide to Telecommunications, 5th Ed, Prentice Hall, 2012. ISBN: 9780137058914
Teacher notes and slides

**Access Conditions and Attendance Excuse**

Not applicable.

**Conditions for Exam Admission**

70% attendance in practical classes (except students with worker-student status) and approval in the laboratory component.

**Evaluation Method**

Composed of 2 components:

Theoretical (T)

Assessment by final exam. Weight of 14 values, with a minimum of 7 values.

Laboratorial (L)

Execution and reports of the practical assignments. Weight of 7 values, with a minimum of 3,5 values.

**Conditions for Results Improvement**

In accordance with the legislation.

| **Date** | **Signature from the lecturer responsible for the course** |
|---|---|
| 27/02/2019 | |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:

**Licenciatura – BsC em Eng. Electrotécnica** (Português)

**Licenciatura – BsC degree in Electrical Eng.** (Inglês)

Academic Year: **2018/2019**

***Program Contents***

**Course Unit** AUTOMATION PROJECT

**Specialization (s)**

**Subject type** **Research Area**

**Year** 3rd **Semester** 2nd **ECTS**

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | | |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | | |
| Tutorial Orientation | 2 | 28 |
| Project | 2 | 28 |
| **Total of Working Hours** | | 182 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | |
| Works / Group Works | |
| Project | 1243 |
| Evaluation | 2 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | | | |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratoty Lectures | | | |
| Tutorial Orientation | Horácio do Carmo Fachada | MSc | Assistant Prof. |
| Project | Horácio do Carmo Fachada | MSc | Assistant Prof. |
| **Responsible(s) Lecturer (s)** | Horácio do Carmo Fachada | | |

At the end of this course unit the learner is expected to be able:

Use all the knowledge obtained during the course to develop a particular electronic and digital control system from a set of requirements, objectives and constraints;

Participate in an automation project, developing hardware solutions and software applications for the required purpose.

Team work with high level skills.

**Program Contents**

It depends on the specific project.

**Bibliography**

Each tutor will give most important references for the project.
Students are free and invited to complete and discuss all study material.

**Access Conditions and Attendance Excuse**

Signature of Teacher:_____

**Conditions for Exam Admission**

**Evaluation Method**

Final project report (30%); laboratory work (60%) and project presentation (10%).

**Conditions for Results Improvement**

| **Date** | **Signature from the lecturer responsible for the course** |
|---|---|
| 15 January 2019 |  |

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:

**Licenciatura – BsC em Engenharia Eletrotécnica - 9109** (Português)

**Licenciatura – BsC in Electrical Engineering - 9109** (Inglês)

Academic Year: **2018 / 2019**

***Program Contents***

| | |
|---|---|
| **Course Unit** | MAINTENANCE AND QUALITY CONTROL |
| **Specialization (s)** | COMMON TRAINING |
| **Subject type** | Automation / Electronics and Telecommunications |
| **Research Area** | Electrical Engineering |
| **Year** | 3 |
| **Semester** | 2 |
| **ECTS** | 5,5 |

**Working Hours**

| Activity Type | Working Hours Per Week | Total Hours |
|---|---|---|
| Theoretical Lectures | 2 | 28 |
| Theoretical-Practical Lectures | | |
| Practical-Laboratoty Lectures | 2 | 28 |
| Tutorial Orientation | | |
| Project | | |
| **Total of Working Hours** | | 143 |

**Unaccompanied Working Hours**

| Activity Type | Total Hours |
|---|---|
| Study | 49 |
| Works / Group Works | 36 |
| Project | |
| Evaluation | 2 |
| Additional | |

**Lecturer**

| Activity Type | Name | Qualifications | Category |
|---|---|---|---|
| Theoretical Lectures | Inácio de Sousa Adelino da Fonseca | PhD | Professor Adjunto |
| Theoretical-Practical Lectures | | | |
| Practical-Laboratoty Lectures | José Pedro Matos Nogueira Amaro | PhD | Professor Adjunto |
| Tutorial Orientation | | | |
| Project | | | |

**Responsible(s) Lecturer (s)** Inácio de Sousa Adelino da Fonseca

**Goals**
Teach and ensure that students acquire the skills described below.

**Skills**
Understand and implement techniques of organization and management of an industrial maintenance department;
Perform diagnostic audits of the maintenance status;
Know how to organize an equipment park;
Develop and implement maintenance plans for machines and equipment;
Perform internal and subcontracted work management;
Apply techniques of fault diagnosis;
Evaluate maintenance costs and times;
Develop and monitor maintenance control indicators;
Identify and apply standardized quality management methodologies;
Know how to research and adopt quality engineering techniques for production or service work;
Know how to design and implement quality control plans;
Know how to develop and monitor quality control indicators.
Understand quality in a business context: Portuguese and European Quality Systems.
Understand the requirements of the Quality Management Systems certification standards.
Understand and apply quality techniques and tools.

Signature of Teacher:

**Program Contents**

1.1 Quality Control Framework
Quality management. Definitions and Concepts. Fundamental concepts of quality.
Metrology, Application of basic quality tools.
1.2 Standardization of "Quality Management"
The 8 principles of quality management. ISO 9000 series standards. Certification process.
1.3 Metrology and control of RMM's
International system of measures; Standards; calibration, testing and certification; RMM's - Monitoring and Measurement Resources
1.4 Process Control
Introduction to SPC (Statistic Process Control); Flowcharts; Pareto diagram; Cause-Effect Diagram; Histograms; Sampling techniques; Scatter diagram
1.5 Portuguese Quality System
Quality Certification.
1.6 Audits
1.7 Vision Tools applied in Quality Control.

2.1 Maintenance Framework and Organization
Management of Maintenance on the prism of electrotechnical engineering. The Costs of Maintenance. Definitions and Concepts.
2.2. Maintenance Management Audit
Modernization Project. The Technical, Organizational and Human Dimensions (TOH). From the various phases of the process, the diagnosis.
Condition of Successful Diagnosis. The Diagnosis as a Reorganization Tool. Audit Framework. Audit Approach. Structure of the Audit. Conduct of the Audit. Intervention Report.
2.3. Organization of the Park
Codification of Equipment. Classification of equipment by its importance. Determination of the degree of urgency and priorities of applications for action.
2.4. Types of Maintenance Work
Improvement Maintenance Works. Preventive Maintenance Works. Corrective Maintenance Works. Other Types of Work.
2.5. Maintenance Planning
Function Planning. The Five Levels of Planning. Specific character of the Planning of Maintenance Works. Technical-Administrative Organization. Supply of spare parts.
2.6. Subcontracting Maintenance Services
Functions to be Subcontracted; Grounds for Subcontracting.
2.7. Maintenance Costs
Direct and Indirect Costs. Optimization of Costs. Cost of Possession of an Equipment. Cost of the Life Cycle of an Equipment.
2.8. Maintenance Times
Fault times. MTBF. MTTR. Non-Production Times.
2.9. Maintenance Control Indicators
Economic and non-economic indicators. Maintainability. Availability. Reliability.
2.10. IMMS (Integrated Maintenance Management Systems)
Computer systems to support maintenance management.
2.11. Statistic
Statistics applied to maintenance management.
2.12. Maintenance management techniques
TPM (Total Productive Maintenance). Terology. Asset Management
2.13. Special maintenance techniques
Thermography. Calibration. Shutdown of maintenance facilities (Shutdowns).

Work Done
1- Quality control of production through the use of inspection systems based on video cameras.
2- Control of installations and equipment through infrared thermographic cameras
3- Carrying out statistical maps for quality control
4- Maintenance Management System
5- Exercise resolution.

**Bibliography**

Diverse material in electronic format, through the moodle platform, from slides, Excel sheets, and Maintenance Management software.
- "Maintenance Lean", by João Paulo Pinto, 2013, Publisher: Lidel, ISBN: 978-972-757-877-1
- "Support for the Maintenance Decision in the Management of Physical Assets", Rui Assis, 2010 Publisher: Lidel, ISBN: 978-989-752-112-6
- "An Introduction to Maintenance", by Luís Andrade Ferreira, Publisher: Publindústria, Porto, 1998, ISBN: 972-95794-4-X
- "Maintenance Focusing on Reliability", by Rui Assis, Publisher: Lidel, 1997, ISBN: 972-757-037-2
- "Organization and Management of Maintenance", from concepts to practice, by José Paulo Saraiva Cabral, Publisher: Lidel.

Signature of Teacher: Inês Fonseca

- Support texts prepared by the Teacher
- "Quality Control", book by Ford.

**Access Conditions and Attendance Excuse**

For students under the Statute of Worker-Student and for components with compulsory attendance and distributed assessment, it may be agreed upon by the teacher responsible for the curricular unit and the student, adjustments to the functioning of these components.
In this case, during the first two teaching weeks, the students must indicate to their respective teacher their status as student worker, establishing immediately how to adjust the functioning of the referred components. The presentation of the employer's work time or other relevant information may be required.

**Conditions for Exam Admission**

It is necessary to obtain a minimum grade of more than 20% in the laboratory component.
75% attendance in theoretical-practical classes.

**Evaluation Method**

-Final Exam - 10 values (minimum of 20% in the quotation of 0-20)
-Work of a theoretical-practical, presential, 2 values to be defined in theoretical classes - use of Matlab / Excel in Quality Control and Maintenance Management.
-Laboratory work - non-presential, group - 4 values to be defined in practical-laboratory classes - to be delivered until the last week of classes (minimum of 20%).
-Work of the Laboratory Practice - 4 values, to be defined in the practical-laboratory classes - to be delivered until the last week of classes (minimum of 20%).
-Students with an evaluation higher than 16 should prove in an oral defense with the theoretical teacher to maintain the classification. If they do not wish to make this defense the evaluation will be limited to 16 values.

**Conditions for Results Improvement**

In accordance with the legislation in force.

| **Date** | **Signature from the lecturer responsible for the course** |
|---|---|
| **21-01-2019** | Inês Fonseca |