**A - General description**

**Programme Title –** Electrical and Computer Engineering

**Qualification awarded –** First cycle degree (180 ECTS credits). Engineer title requires professional association membership.

**Admission requirements –** General Application for Admission to Higher Education, re-enter and special admission schemes. National examinations in the core disciplines: Mathematics or Physics or Chemistry.

**Educational and Professional goals –** The degree in Electrical and Computer Engineering is a 6-semester (3 years) degree. The graduation includes the traditional electrical disciplines and others in more specialised fields. It aims to provide important foundations in system conception, design, planning and implementation in areas such as electrotechnology, energy, electronics, telecommunications, information technologies, robotics, process control, computer and industrial automation.

The degree is divided into two specialization branches: Energy and Industrial Automation and have the following educational and scientific/technological objectives:

*- Energy:*

Graduates in electrical and computer engineering from the energy branch will be able to design, produce, explore, manage and maintain energy power facilities for energy transformation, use and distribution. They should also be able to comply with all the applicable safety standards for electrical installations and to design, select and maintain power equipments in industrial units, electronic systems, electromechanical and automation systems in extraction and transformation installations, and perform technical services. Other areas such as green power, management and energy quality and project management are also part of their roles.

*- Industrial automation:*

Graduates in electrical and computer engineering from the industrial automation branch must be qualified to design, manage, control and maintain industrial systems, including automated production systems, computer industrial systems for the control and supervision of processes, and program robotic control systems and communication systems. The graduates will also have skills in electronics, control electromechanical systems control, electrical installations and telecommunications and project development.

**Access to further studies –** The Electrical and Computer Engineering degree allows access to post-graduation studies such as Master and PhD programmes.

**Course structure diagram with credits (60 per year) –** Three-year course (six semesters in total, 30 ECTS credits each):

| Course Title | Year | Semester | Number of credits |
|---|---|---|---|
| Mathematical Analysis I | 1 | 1 | 6 |
| Digital Systems | 1 | 1 | 6 |
| Algebra | 1 | 1 | 6 |
| Introduction to Computer Programming and Algorithms | 1 | 1 | 6 |
| Physics | 1 | 1 | 6 |
| Mathematical Analysis II | 1 | 2 | 6 |
| Electromagnetism | 1 | 2 | 6 |
| Object-Oriented Programming | 1 | 2 | 6 |
| Electrical Circuits Analysis | 1 | 2 | 6 |
| Computer Architecture and Operating Systems | 1 | 2 | 6 |
| Databases | 2 | 1 | 6 |
| Mathematics Applied to Electrotechnology | 2 | 1 | 6 |
| Electronics I | 2 | 1 | 6 |
| Electrical Installations | 2 | 1 | 6 |
| Project Planning and Management | 2 | 1 | 6 |
| Electronics II | 2 | 2 | 6 |
| Instrumentation Electronics | 2 | 2 | 6 |
| Systems Theory | 2 | 2 | 6 |
| Power Systems Fundamentals | 2 | 2 | 6 |
| Telecommunications Fundamentals | 2 | 2 | 6 |
| **Branch: Energy** | | | |
| Materials and Energy Conversion | 2 | 2 | 6 |
| Legislation and Design of Electrical Installations | 2 | 2 | 6 |
| Control Theory | 3 | 1 | 6 |
| Industrial Automation | 3 | 1 | 6 |
| Maintenance | 3 | 2 | 6 |

| | | | |
|---|---|---|---|
| Project | 3 | 1 and 2 | 12 |
| **Branch: Industrial Automatation** | | | |
| Control of Electromechanical Devices | 3 | 1 | 6 |
| Data Networks | 3 | 2 | 6 |
| Industrial Networks | 3 | 2 | 6 |
| Industrial Robotics | 3 | 2 | 6 |
| Embedded Systems | 3 | 1 | 6 |
| **Branch: Energy** | | | |
| Power Electronics | 3 | 2 | 6 |
| Electrical Machines | 3 | 2 | 6 |
| Electromechanical Drive Control | 3 | 2 | 6 |
| Energy Distribution and Micro-generation | 3 | 2 | 6 |
| Energy Quality and Management | 3 | 2 | 6 |

**Final examination, if any –** not applicable

**Examination and assessment regulations –** final examination not required; examination and assessment defined for each individual course unit

**ECTS departmental co-ordinator –** Prof. Jorge Guilherme

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Mathematical Analysis I |
| **Course code** | 91121 |
| **Type of course** | One-semester course |
| **Level of Course** | I |
| **Year of study** | First |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | Luís Merca, Manuela Fernandes |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | 1- To give the basic concepts and mathematical methods usually used in this engineering degree.<br>2- To provide the students with skills to work with differential and integral calculus in functions of one real variable. |
| **Prerequisites** | Not applicable |
| **Course contents** | 1- Preliminaries.<br>2- Real functions of a real variable.<br>3- Limits and continuity.<br>4- Differential calculus<br>5- Integral calculus. |
| **Recommended reading** | Texts and support material available in the course web page.<br><br>Jaime Carvalho e Silva; "Princípios de Análise Matemática Aplicada". Mc Graw-Hill.<br>Swokowski, E. W.; "Cálculo com Geometria Analítica". Mc Graw-Hill.<br>Piskounov, N.; "Cálculo Diferencial e Integral". Edições Lopes da Silva, Porto.<br>Simmons, G. F.; "Cálculo com Geometria Analítica". Mc Graw-Hill.<br>Anton, Howard; "Cálculo um novo horizonte. Volume I". Bookman.<br>Stewart, James; "Cálculo. Volume I". Pioneira.<br>Larson, Ron; "Cálculo. Volume I". 8ª Edição. McGraw Hill. |
| **Teaching methods** | Theoretical lectures, with presentation and exemplification of the proposed subjects. Theoretical-practical classes involving problem solving. |
| **Assessment methods** | Continuous assessment: two written tests.<br>Final assessment: one written examination |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Digital Systems |
| **Course code** | 91122 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | First |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | Manuel Fernando Martins de Barros |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | An introductory course in digital electronics focusing on analytical reasoning and basic digital design using the standard integrated circuits (ICs) used in industry today. Basic notions of digital circuit analysis and design synthesis are introduced, supported by modern CAD software. |
| **Prerequisites** | No prior knowledge of digital electronics is assumed. |
| **Course contents** | 1 – Introduction to the laws and postulates of Boolean Algebra.<br>2 – Simplification of logic networks with Karnaugh Maps.<br>3 – Study of logic design with integrated circuit (IC) gates.<br>4 – Number system fundamentals.<br>5 – Introduction to combinatorial circuits, mux, demux, decoders.<br>6 – Study of encoders, comparators and arithmetic components.<br>7 – Introduction to sequential logic, flip-flops, counters, RAMs.<br>8 – Synthesis and analysis of digital circuits with CAD software.<br>9 – Study of ICs logic families, properties and main characteristics<br>10–Introduction to Programmable Logic design with HDLs. |
| **Recommended reading** | Text and support materials are available in the web page of course unit and the Moodle system.<br>1. John Wakerly, *Digital Design Principles and Practices*, 3rd edition, Prentice Hall (2000)<br>2. Cuesta, L. E Padilla, G., *Electrónica Digital*, Mc Graw Hill<br>3. Nelson, Victor P., Nagle, H. Troy, Carrol, Bill D., e Irwin, J. David., *Digital Logic Circuit Analysis and Design*, Prentice Hall. |
| **Teaching methods** | Theoretical classes in which digital system design methods and techniques will be described and demonstrated and practical laboratory classes including problem solving. |
| **Assessment methods** | Written test during the regular exam period and practical assignments done during the laboratory classes (7 practical assignments approx.) |
| **Language of instruction** | Portuguese. |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Algebra |
| **Course code** | 91123 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | First |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | João Patrício; Carlos Perquilhas; Pedro Carrasqueira |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | To provide insight on Matrix Linear Algebra, making special emphasis on the discussion and the exact and approximate computation of the solution of linear systems of equations. Furthermore, Vector Spaces, Determinants, Matrix Eigenvectors, and Eigenvectors are studied. These are topics of utmost interest in many Engineering applications. |
| **Prerequisites** | NA |
| **Course contents** | 1 - Matrices and systems of linear equations.<br>2 - Vector spaces.<br>3 - Determinants.<br>4 - Eigenvalues and eigenvectors of square matrices. |
| **Recommended reading** | Lecture notes available at the IPT *e-learning* platform.<br><br>F. Dias Agudo, *Introdução à Álgebra Linear e Geometria Analítica*, Escolar Editora, Lisboa, 1978. E. Giraldes, P. Smith, *Curso de Àlgebra Linear e Geometria Analítica,* McGraw-Hill, Lisboa, 1995. L. T. Magalhães, *Álgebra Linear como Introdução à Matemática Aplicada*, Texto Editora, 1989. W. Nicholson*, Linear Algebra with Applications*, PWS Publishing Company, Boston, 1995. M. Heath, *Scientific Computing: an Introductory Survey*, McGraw-Hill, 2007. |
| **Teaching methods** | Theoretical and theoretical-practical lectures, with presentation and exemplification of the proposed subjects. |
| **Assessment methods** | Continuous assessment: two written tests.<br><br>Exam assessment: one written test. |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

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| | |
|---|---|
| **Course title** | Introduction to Computer Programming and Algorithms |
| **Course code** | 91124 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | First |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | Luís Miguel Lopes de Oliveira |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Solving problems using algorithms.<br>Using a programming language to express an algorithm.<br>Using 'C' programming language to construct a computer program. |
| **Prerequisites** | NA |
| **Course contents** | Introduction to Computers and Programming.<br>Introduction to Algorithms and programming languages.<br>Data processing and manipulation.<br>Control flow: Statements and blocks; IF-Else; Switch; While; For; Do.<br>Functions and program Structure.<br>Pointers and arrays.<br>Structures.<br>Dynamic memory allocation.<br>Files: input and output. |
| **Recommended reading** | "C Programming Language", Ritchie and Kernighan, Prentice Hall, May 1, 1990, ISBN 978-0131108592<br>"Linguagem C", Luís Damas. FCA, 1999 |
| **Teaching methods** | Lectures: course content presentation<br>Laboratory sessions: Laboratorial classes with practical experiments. |
| **Assessment methods** | Practice (40%):<br>Assignments and homework.<br>Reports and presentations.<br>Theory (60%):<br>Exams |
| **Language of instruction** | Portuguese |

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## B – Description of individual course units

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|---|---|
| **Course title** | Physics |
| **Course code** | 91125 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | First |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | Rui Gonçalves |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Development of skills to analyse and solve mechanical problems (kinematics and dynamics) with few ideal bodies. |
| **Prerequisites** | Basic knowledge of calculus |
| **Course contents** | 1 – Vectorial, differential and integral notions.<br>2 – Measures and units. International Unit System.<br>3 – Material point kinematics.<br>4 – Material point dynamics. Force.<br>5 – Work and Energy.<br>6 – Rigid Body, Static and Elasticity.<br>7 –Vibrational movement. |
| **Recommended reading** | Raymond A. Serway e John W. Jewett, Jr., *Physics for Scientists and Engineers with Modern Physics*, Thomson, Brooks/Cole, 6th ed. (2004)<br>Richard P. Feynman, Robert B. Leighton e Mattew Sands, *The Feynman Lectures on Physics*, vol. I. Addison-Wesley Publishing Company, 1977<br>Alonso & Finn, *Física - um curso Universitário*, vol. I - Mecânica, vol. II - Campos e Ondas, Edgard Blutcher |
| **Teaching methods** | Theoretical classes teaching concepts, principles and applications of physical laws ruling mechanics. Practical classes proposing and solving applied exercises. |
| **Assessment methods** | One individual research work with report and one written test. |
| **Language of instruction** | Portuguese |

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## B – Description of individual course units

| | |
|---|---|
| **Course title** | Mathematical Analysis II |
| **Course code** | 91126 |
| **Type of course** | One semester course |
| **Level of Course** | II |
| **Year of study** | First |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Carlos Perquilhas, Luís Merca, Miguel Caceiro, Manuela Fernandes |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | 3- To give the basic concepts and mathematical methods usually used in this engineering course.<br>4- To provide the students with skills to work with differential and integral calculus in functions of several real variables. |
| **Prerequisites** | NA |
| **Course contents** | 6- Numerical and Functions Series.<br>7- Real functions of several real variables.<br>8- Multiple Integrals. |
| **Recommended reading** | Texts and support material available in the course title's web page.<br><br>Jaime Carvalho e Silva; "Princípios de Análise Matemática Aplicada". Mc Graw-Hill.<br>Swokowski, E. W.; "Cálculo com Geometria Analítica". Mc Graw-Hill.<br>Piskounov, N.; "Cálculo Diferencial e Integral". Edições Lopes da Silva, Porto.<br>Simmons, G. F.; "Cálculo com Geometria Analítica". Mc Graw-Hill.<br>Anton, Howard; "Cálculo um novo horizonte. Volume II". Bookman.<br>Stewart, James; "Cálculo. Volume II". Pioneira.<br>Larson, Ron; "Cálculo. Volume II". 8ª Edição. McGraw Hill.<br>Zill D., Cullen M.; "Advanced Engineering Mathematics".PWS<br>Azenha A., Jerónimo M., "Cálculo Diferencial e Integral em R e $R^n$ " Mac Graw-Hill. |
| **Teaching methods** | Theoretical lectures with presentation and exemplification of the proposed subjects. Theoretical-practical lectures where exercises are proposed and solved. |
| **Assessment methods** | Continuous assessment: two written tests.<br>Final assessment: one written test. |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Electromagnetism |
| **Course code** | 91127 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | First |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Rui Gonçalves |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Development of skills to analyse and solve electromagnetic problems. |
| **Prerequisites** | Basic knowledge of calculus and physics |
| **Course contents** | 1 – Electrostatic.<br>2 – Moving charges under electric field.<br>3 – Magnetostatic<br>4 – Moving charges under electric and magnetic field.<br>5 – Magnetic induction.<br>6 – RC, RL and RLC circuits.<br>7 – Magnetic and Electric field on matter.<br>8 – Electromagnetic waves |
| **Recommended reading** | Sushil Kumar Mendiratta, *Introdução ao Electromagnetismo*", Manuais Universitários, Fundação Calouste Gulbenkian, 1984<br>P. Hammond, *Electromagnetism for Engineers- an introductory course,* Oxford Science Publications, Fourth Edition 1997<br>L. Brito, M. Fiolhais e C. Providência, *Campo Electromagnético,* McGraw-Hill, 1999 |
| **Teaching methods** | Theoretical classes teaching concepts, principles and applications of physical laws ruling electromagnetism. Practical classes proposing and solving applied exercises. |
| **Assessment methods** | One individual research work with report and one written test. |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Object - Oriented Programming |
| **Course code** | 91128 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | First |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | António Manuel Rodrigues Manso |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | 1 - Apply the basic principles of problem solving using the Object-Oriented programming;<br>2 - Develop functional code through the C++ language, and its class libraries;<br>3 - Manage situations of error and exception in the software development;<br>4 - Develop applications with graphical interfaces directed by events. |
| **Prerequisites** | Basic knowledge of programming. |
| **Course contents** | 1 - Introduction to Object-Oriented Programming<br>2 - Visual programming.<br>3 - Programming with classes.<br>4 - Definition of library classes. |
| **Recommended reading** | 1 -Texts and other materials available on the e-learning platform of the curricular unit.<br>2 - Guerreiro, Pedro João Valente Dias : Programação com Classes em C++, FCA, 2000<br>3 - Stroustroup, Bjarne : The C++ Programming Language, Addison-Wesley, 1997<br>4 - Eckel, Bruce : Thinking in C++ , 2003 |
| **Teaching methods** | 1- Theoretical classes involving presentation of the course contents.<br>2 - Practical classes for problem resolution and consolidation of knowledge using the computer.<br>3 - Individual guidance of students as regards to the development of projects and clarification of doubts. |
| **Assessment methods** | Practical works and written "closed book" test. |
| **Language of instruction** | Portuguese |

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## B – Description of individual course units

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|---|---|
| **Course title** | Electrical Circuits Analysis |
| **Course code** | 91129 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | First |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Francisco José Alexandre Nunes<br>Ana Carla Vicente Vieira<br>Raul Manuel Domingos Monteiro |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Understanding and using of DC an AC circuits analysis main concepts and techniques. Ability to use time domain analysis of 1st and 2nd order circuits. Ability to use frequency domain linear circuits analysis. |
| **Prerequisites** | NA |
| **Course contents** | Current, voltage and main components in electrical circuits<br>Kirchhoff Laws<br>Analysis Methods<br>Electrical circuits Theorems<br>Capacitors and inductors<br>1st and 2nd order Analysis<br>AC Analysis |
| **Recommended reading** | • Meireles, Vítor; "Circuitos Eléctricos"; Lidel; 2003;<br>• Nunes, Francisco; "Acetatos de Análise de Circuitos" (Engª Electrotécnica e de Computadores; 1ºAno/2ºSem, ESTT – IPT).<br>• Vieira, Ana; "Análise de Circuitos – Caderno de Exercícios" (Engª Electrotécnica e de Comp.; 1ºAno/2ºSem –, ESTT – IPT).<br>• Vieira, Ana; "Análise de Circuitos - Capítulo 1 – Conceitos Básicos" (resumo de conceitos básicos sobre electricidade).<br>• Silva, Manuel de Medeiros; "Introdução aos Circuitos Eléctricos e Electrónicos"; Gulbenkian; 1996; |
| **Teaching methods** | Expositive classes<br>Practical classes involving problem solving |
| **Assessment methods** | Periodical tests or final exam |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Computer Architecture and Operating Systems |
| **Course code** | 911210 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | First |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Ana Lopes and Gabriel Pires |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Provide the students with technical knowledge related to the basic operation of a computer, and the supporting software. |
| **Prerequisites** | Circuits and Digital systems |
| **Course contents** | 1 - Organization and Computer Architecture, and processors<br>2 - Memory<br>3 - I/O systems<br>4 - Computer architecture advanced topics<br>5 - Introduction to operating systems: Introduction to process management, memory management, and file management |
| **Recommended reading** | [1] – Patterson, David A. and Henessy, John L. - Computer Organization and Design, Prentice Hall, 2004.<br>[2] – Carter, Nicholas – Teoria e Problemas de Arquitetura de Computadores, Coleção Schaum, 2002.<br>[3] – Arroz, Guilherme, Monteiro, José e Oliveira, Arlindo - Arquitectura de Computadores: dos Sistemas Digitais aos Microprocessadores, IST Press, 2007.<br>[4] – Tanenbaum, Andrew S. – Operating Systems: Design and Implementation, Prentice Hall, 1997. |
| **Teaching methods** | Lectures, practical exercises and lab experiments |
| **Assessment methods** | Written Test (60%), Lab work (40%) (grading requirements: A minimum of 45% in the written Test and a minimum of 50% in the Labs) |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Databases |
| **Course code** | 911211 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Second |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | Casimiro Batista, Ana Vieira |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | This course will provide a thorough introduction to the theory and practice of database systems. The emphasis will be on theoretical considerations involved in modelling data and in designing easy to use and efficient database systems. The students will learn Database concept, Data Structure, Data Models, various approaches to Database design, strengths of relational model and Normalization. |
| **Prerequisites** | NA |
| **Course contents** | 1 - Objectives and functions of Database Management Systems (DBMS).<br>2 - Hierarchical model. Network model. Relational model.<br>3 - Relationships. Instances and schemes. Data dictionary . Keys. Primary key, foreign key and indices. Integrity and rules.<br>4 - Functional dependencies and normalization. First normal form (1FN), second normal form (2FN), third normal form (3FN) and Boyce-Codd normal form.<br>5 - Entity-relationship method. Extended E-R.<br>6 - SQL. SQL's DDL commands. SQL's DML commands. |
| **Recommended reading** | 1 – Texts and other material provided by the course lecturers.<br>2 – C. J. Date - An introduction to database systems". |
| **Teaching methods** | Theoretical classes where the study methods are described and exemplified; Theoretical-practical classes where application exercises are solved; and Laboratory Practices. |
| **Assessment methods** | Theory test. Laboratory works/exercises; as well as Development and Presentation of a Project. |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Mathematics Applied to Electrotechnology |
| **Course code** | 911212 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Second |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | João Manuel Patrício; Maria Manuela Fernandes; Carlos Perquilhas Baptista; António Miguel Caceiro |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Acquisition of the basic mathematical skills required for the remaining courses, such as Electricity, Electrical Machines, Power Electronic Systems and Industrial Automation. |
| **Prerequisites** | NA |
| **Course contents** | 1 - Introduction to Logic and Set Theory.<br>2 - Vectors and Matrices.<br>3 -Trigonometry.<br>4 - Complex Numbers.<br>5 - Differential and Integral Calculus. |
| **Recommended reading** | Lecture notes available at the IPT *e-learning* platform.<br><br>E. Giraldes, P. Smith; Curso de Álgebra Linear e Geometria Analítica; Mcgraw-Hill, Lisboa, 1995.<br>L. T. Magalhães; Álgebra Linear como Introdução à Matemática Aplicada; Texto Editora, 1989.<br>N. Piskounov; Cálculo Diferencial e Integral"(vols. 1 e 2); Edições Lopes da Silva, Porto,1978.<br>R. Larson, R. Hostetler, B. Edwards; Cálculo (vol. 1); Mcgraw-Hill Interamericana do Brasil, 2006.<br>M. Saraiva, M. Silva; Primitivação; Edições Asa, 1997. |
| **Teaching methods** | Theoretical and practical classes including presentation and exemplification of the proposed subjects. |
| **Assessment methods** | Continuous assessment: three intermediate tests.<br><br>Exam assessment: one written test. |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

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|---|---|
| **Course title** | Electronics I |
| **Course code** | 911213 |
| **Type of course** | One-semester course |
| **Level of Course** | I |
| **Year of study** | Second |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | Jorge Guilherme |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Provide knowledge of the main semiconductor devices and circuits. The students will become familiar with matters such as diodes, bipolar and MOS transistors, operational amplifiers, and their main applications. |
| **Prerequisites** | Circuit analysis |
| **Course contents** | - Semiconductor properties<br>- Diodes, bipolar, MOS and JFET transistor<br>- LED diodes and Hall effect<br>- Basic diode networks, rectifiers, limiters, log amplifiers<br>- Basic transistor networks. Single stage transistor amplifiers<br>- Operational amplifiers. Precision rectifiers<br>- Comparators<br>- Oscillators with operational amplifiers.<br>- Digital electronics. Logic gates, microelectronics technology, digital families, TTL, ECL and CMOS. Memories RAM, ROM, EEPROM, FLASH.<br>- Differential pair. Active loads.<br>- Current sources. Precision voltage generators, band-gap.<br>- Power supplies. Protections circuits, temperature and voltage, short circuit, foldback. |
| **Recommended reading** | -Manuel de Medeiros Silva, Introdução aos circuitos Eléctricos e Electrónicos, ed. F.C. Gulbenkian, 1996.<br>-Manuel de Medeiros Silva, Circuitos com Transístores Bipolares e MOS, ed. F.C. Gulbenkian, 1999.<br>-Sedra/Smith, Microelectronic Circuits, Oxford Press, 1998.<br>-Paul Gray, Paul J. Hurst, Stephen H. Lewis and Robert G. Meyer, Analysis and Design of Analog Integrated Circuits, Wiley 2001. |
| **Teaching methods** | Theoretical classes, Theoretical-practices and Laboratory Practices. |
| **Assessment methods** | Written Examination 75%, Practical Works 25%. |
| **Language of instruction** | Portuguese |

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## B – Description of individual course units

| | |
|---|---|
| **Course Title** | Electrical Installations |
| **Course Code** | 911214 |
| **Type of Course** | One-semester course |
| **Level of Course** | NA |
| **Year of Study** | Second |
| **Semester/Trimester** | First |
| **Number of credits** | 6 |
| **Name of Lecturer** | Mário Gomes |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Acquire problem solving skills concerning electrical installations such as:<br>- select electrical safety apparatus and appliances;<br>- dimension electrical ducts and safety devices and equipment;<br>- design and dimension electrical switchboards<br>- draw up and explore transformer stations;<br>- draw up indoor and safety lighting |
| **Prerequisites** | Previous knowledge of electrical engineering, electrical equipments and materials, electrical machines and AutoCad. |
| **Course contents** | Electrical schemes and symbols. Phases, constitution and execution procedures of an electrical and electronic project. Electrical ducts. Low-voltage appliances. Overcurrent (overload and short-circuit).<br>Calculus of low voltage ducts and safety apparatus<br>Safety of people and equipment.<br>Industrial switchboards .Transformer stations. Indoor lighting and safety project. ITED: Characterization. Materials, devices and equipments. Project, installation and testing. |
| **Recommended Reading** | "Regras Técnicas das Instalações Eléctricas de Baixa Tensão" (Portaria nº949-A/2006).<br>"Regulamento de Segurança Subestações, PT e de Seccionamento".<br>"Guia Técnico das Instalações Eléctricas", Certiel, Josué Lima Morais, José Marinho Gomes Pereira, 2006.<br>"Guia Técnico MG-Calc", edição Merlin-Gerin, L.M. Vilela Pinto.<br>"Manual ITED (Prescrições e Especificações Técnicas)", 1ª Ed., ANACOM, 2004 |
| **Teaching Methods** | Lectures with illustrative cases. Theoretical-practical classes involving concept application and problem solving. |
| **Assessment Methods** | Theoretical-practical work (30%) and periodical written test or final examination (70%). |
| **Language of Instruction** | Portuguese |

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## B – Description of individual course units

| | |
|---|---|
| **Course title** | Project Planning and Management |
| **Course code** | 911215 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Second |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | Pedro Manuel Granchinho de Matos |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | - Analyse problems in a business context and explain the decision-making using optimization tools;<br>- Understand the basic methodology for project analysis in terms of operations management, in conditions of certainty and uncertainty;<br>- Understand the basic methodology for the analysis of economic and financial viability of investment projects and apply them to business problems involving decision-making. |
| **Prerequisites** | NA |
| **Course contents** | 1 Linear Programming;<br>2 Forecasting methods;<br>3 Analyse of Investment Projects;<br>4 Projects Management;<br>5 Production Management; |
| **Recommended reading** | [1] – Granchinho de Matos, Pedro M. – Sebenta da disciplina de Planeamento de Gestão de Projectos.<br>[2] – Winston, Wane L. – Operations Research – Applications and Algorithms, Duxbury Press, 1993.<br>[3] – Chase, Richard ; Aquilano, Nicholas; Jacobs, Robert - Operations Management for Competitive Advantage, McGraw-Hill Irwin 2001.<br>[4] – Cebola, António; Elaboração e análise de projectos de investimento – Edição Sílabo. |
| **Teaching methods** | Theoretical classes describing and exemplifying the concepts provided and theoretical and practical classes involving implementation of the concepts learned. |
| **Assessment methods** | Written exam.<br>Practical work carried out during the semester |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Electronics II |
| **Course code** | 911216 |
| **Type of course** | One-semester course |
| **Level of Course** | II |
| **Year of study** | Second |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Jorge Guilherme |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Provide skills that enable the students to understand the main circuits used in electronics and analyse or design general electronic circuits. |
| **Prerequisites** | Circuit analysis, Electronics I |
| **Course contents** | - Analogue multipliers<br>- Output stages in class A, B, C and D<br>- Discrete and integrated amplifiers. Audio power amplifiers<br>- Frequency response of analog circuits<br>- Feedback and stability<br>- Sinusoidal oscillators<br>- Filters. Approximation problem. Continuous and switched capacitor filters<br>- Phase lock loops and frequency synthesizers<br>- Signal converters, ADC, ADC and VF<br>- Programmable logic devices<br>- Mixers<br>- Noise analyses<br>- Transmission lines |
| **Recommended reading** | •Manuel de Medeiros Silva, *Introdução aos Circuitos Eléctricos e Electrónicos*, ed. F.C. Gulbenkian, 1996.<br>•Manuel de Medeiros Silva, *Circuitos com Transístores Bipolares e MOS*, ed. F.C. Gulbenkian, 1999.<br>•Sedra/Smith, *Microelectronic Circuits*, Oxford University Press, 1998.<br>•Paul Gray, Paul J. Hurst, Stephen H. Lewis and Robert G. Meyer, *Analysis and Design of Analog Integrated Circuits*, John Wiley & Sons, 2001.<br>•Jacob Baker, *CMOS Circuit Design, Layout and Simulation*, John Wiley & Sons, 2005.<br>•Gobind Daryanani, *Principles of Active Network Synthesis and Design*, John Wiley & Sons, 1976. |
| **Teaching methods** | Lectures, Theoretical-practical classes and Laboratory Practice. |
| **Assessment methods** | Written Examination 75%, Practical Works 25%. |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Instrumentation Electronics |
| **Course code** | 911218 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Second |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Jorge Guilherme |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Provide knowledge of the main equipments and techniques to measure electric and electronic signals. |
| **Prerequisites** | Circuit analysis, Electronics I |
| **Course contents** | - Measurement errors<br>- Electromagnetic instruments<br>- Voltage, current, power and energy measurement<br>- Bridges<br>- Digital instrumentation, voltage meters and frequency meters<br>- Signal generators<br>- Oscilloscopes<br>- Spectrum analysers<br>- Sensors and signal acquisition<br>- Data converters characteristics<br>- Instrumentation interfaces |
| **Recommended reading** | •FERNANDES, José, Medidas Eléctricas e Instrumentação, Escola Superior de Tecnologia de Tomar<br>•David A. Bell, Electronic Instrumentation and Measurements, Prentice Hall 1994.<br>•A. Gregory, An Introduction to Electrical Instrumentation and Measurement Systems, The Macmillan Press LTD, 1973.<br>•Alan S. Morris, Principles of Measurement and Instrumentation, Prentice Hall 1993. |
| **Teaching methods** | Lectures, theoretical-practical classes and laboratory practice. |
| **Assessment methods** | Written Examination 75%, Practical Works 25%. |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Systems Theory |
| **Course code** | 911217 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Second |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Paulo Coelho |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | This course will provide concepts of the systems and signs theory, with emphasis to time invariant linear continuous systems. The practical component will familiarize the students with the MATLAB, a computer tool that allows analysis and simulation of systems and signs. |
| **Prerequisites** | Algebra and Mathematical Analysis and knowledge of electrical concepts (e.g. Circuit Analysis). |
| **Course contents** | 1 – Introduction: Signals and systems classification<br>2 – Analysis of continuous LIT systems in time domain<br>3 – Analysis of LIT systems in frequency domain: Laplace transform; transfer function; stability; transient response and steady state response, frequency response of 1st and 2nd order systems<br>4 – Block diagram representation<br>5 – Mathematical modelling of systems. Servomechanisms<br>6 – Basic Systems Identification<br>7 – Transient and steady state analysis of higher-order systems<br>8 – State-space systems representation |
| **Recommended reading** | 1 – Texts and other material available in the course web page.<br>2 – B. P. Lathi, “Linear Systems and Signals”, Berkeley-Cambridge Press, 1992.<br>3 – Isabel Lourtie, “Sinais e Sistemas”, Escolar Editora, 2002.<br>4 – The Student Edition of Matlab, Prentice-Hall, 1995. |
| **Teaching methods** | Theoretical classes where the study methods are described and exemplified; Theoretical-practical classes where application exercises are solved; and Laboratory Practices. |
| **Assessment methods** | Written “closed book” examination in regular exam periods ( 75%); and Practical Works (25%). |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Telecommunications Fundamentals |
| **Course code** | 911231 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Second |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Pedro Daniel Frazão Correia |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | 1- To understand the frequency analysis of continuous signals using Fourier Transform;<br>3- To understand the physical impairments of transmission systems;<br>4- To characterize the different transmission media;<br>5- To understand modulation systems with continuous carrier applied to analogue and digital transmission. |
| **Prerequisites** | Mathematical Analysis, Complex Analysis and Basic Electronics. |
| **Course contents** | 1-Introduction to telecommunications;<br>2-Signals and Systems;<br>3-Sampling and Pulse-Code Modulation;<br>4-Transmission media;<br>5-Analogue modulation with continuous carrier;<br>6-Principles of digital data transmission; |
| **Recommended reading** | 1- " Modern Digital and Analog Communication Systems", B. P. Lathi, Oxford University Press, 1998;<br>2- "Signal Processing and Linear Systems, B. P. Lathi – Oxford University Press,1998;<br>4- "Data Communications Networking", Behrouz A Forouzan, Deanza College , 4th Edition, McGraw-Hill;<br>6- "Signals and Systems" , Hwei P. Hsu , Schaum's Outline Series-Mc-Graw Hill , 1995; |
| **Teaching methods** | - Lectures;<br>- Problem solving classes;<br>- Laboratory classes; |
| **Assessment methods** | Exam (70%) (a minimum of 45% is mandatory)<br>Laboratory (30%) (a minimum of 45% is mandatory) |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Power Systems Fundamentals |
| **Course code** | 911232 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Second |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Carlos Alberto Farinha Ferreira |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Understand the functioning principles and constitution of Electrical Machines and their equivalent circuits. Obtain skills to chose and operate Electrical Machines. Understand the electrical energy chain: production, transportation and distribution. |
| **Prerequisites** | Knowledge of physics (electromagnetic and mechanics) and electrical circuits. |
| **Course contents** | 1 - Foundations of electrical Machines.<br>2 – Transformer: working principle, constitution, equivalent electric circuit, tests, efficiency, energy and power flux, starting.<br>3 - Working principle, constitution, equivalent electric circuit, tests, efficiency, energy and power flux, starting, speed regulation and inversion of rotation of:<br>• CC machine.<br>• Synchronous machine (brief introduction).<br>• Asynchronous machine. |
| **Recommended reading** | • José Fernandes, “Sebenta de máquinas eléctricas”, IPT.<br>• A.E. Fitzgerald, Charles Kingsley Jr., Stephen D. Umans, “Electric Machinery”, McGraw-Hill, sixth edition, 2003.<br>• Diogo de Paiva Leite Brandão, “Máquinas eléctricas”, Fundação Calouste Gulbenkian, 1984. |
| **Teaching methods** | Lectures, exercises, and practical exercises (laboratorial). |
| **Assessment methods** | Test: 70%. Practice (laboratorial): 30%. |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Materials and Energy Conversion (Branch: Energy) |
| **Course code** | 911219 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Second |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | José Fernandes |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Understand the electric and magnetic properties of the main materials applied in electrical engineering;<br>Understand the basics of energy conversion and its application in transducers and linear & rotating electric machines.<br>Study the steady state operating mode of DC machines and transformers. Upon completion of this course, including lab experiments, students should be able to operate these types of machines safely. |
| **Prerequisites** | Knowledge of Electromagnetism, electrical circuit analysis and mathematics (partial derivatives and complex numbers) |
| **Course contents** | The energy conversion approach to produce force or torque. Fundamentals of DC Machines, windings and field systems. Characteristic curves, losses and efficiency of DC motors. Starting and speed control methods of DC motors. Universal motors working under direct and alternate currents. Fundamentals and circuit model of transformers. Internal voltage drop in loaded transformers and their taps. Parallel of single and three-phase transformers. Laboratory tests, losses and efficiency of transformers.<br>10 - Electric and magnetic properties of materials in engineering. |
| **Recommended reading** | Notebook with a professor's lectures.<br>“Máquinas Eléctricas”, A. E. Fitzerald – Charles Kingsley Jr - McGraw-Hill. |
| **Teaching methods** | Lectures including exposition of the course contents. Practical classes including exercise solving. Laboratory classes where the students have the opportunity to learn the functioning of some machines and perform related tests. |
| **Assessment methods** | Final mark= 2/3 Mark of a written exam + 1/3 Average mark of laboratory work |
| **Language of instruction** | Portuguese |

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## B – Description of individual course units

| | |
|---|---|
| **Course Title** | Legislation and Design of Electrical Installations (Branch: Energy) |
| **Course Code** | 911220 |
| **Type of Course** | One-semester course |
| **Level of Course** | NA |
| **Year of Study** | Second |
| **Semester/Trimester** | Second |
| **Number of credits** | 6 |
| **Name of Lecturer** | Mário Gomes |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Know, understand and apply applicable legislation and regulations concerning the design of electrical and telecommunications installations: RTEBT and ITED. Design general electrical installations and project level 3 and level 5 installations. Design telecommunication installations in buildings and project household installations. Use AutoCAD to design electrical and telecommunications installations. |
| **Prerequisites** | Basic knowledge of AutoCad and electrical installation matters. |
| **Course contents** | Carry out an execution and cost estimate project. Draw up a project for licensing purposes. Regulations, standards and legislation as applied to electrical installation projects. Regulations, standards and legislation as applied to telecommunication installation projects. Draw up an electrical installation project for a household with or without service areas (level 5). Draw up a telecommunication project for a household. |
| **Recommended Reading** | - Portaria nº 949 – A / 2006 de 11 de Setembro.<br>- Guia Técnico das Instalações Eléctricas – José Lima Morais e José M. Gomes Pereira Ed. CERTIEL – 2006.<br>- HABITAT-PRO – Ed Schneider de 2007.<br>- Decreto- Lei nº 59/2000 de 19 de Abril.<br>- Manual ITED, Prescrições e Especificações Técnicas - ANACOM, 1ª edição, Julho de 2004.<br>- MGCalc, edição Merlin Gerin, L.M. Vilela Pinto, Janeiro de 1993.<br>- Guia Técnico Solidal, Edição Solidal – condutores eléctricos SA, 4ª edição, Maio de 1995. |
| **Teaching Methods** | Lectures where case studies are presented to illustrate applicable standards and legislation. Laboratory classes where the students have the opportunity to practice with AutoCAD. |
| **Assessment Methods** | Presentation and discussion of practical work carried out during the semester. |
| **Language of Instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Control Theory |
| **Course code** | 911221 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Third |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | Paulo Coelho |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | The objectives of this course are to provide knowledge of several automatic control systems structures, to develop competences in the design of classical control systems using time invariant linear continuous systems and to analyse stability and performance. |
| **Prerequisites** | Knowledge of Signals and Systems and of Laplace transform. |
| **Course contents** | 1 – Control systems introduction.<br>2 – Time domain analysis, in open and closed loop: transient response, steady state error analysis, stability (Routh /Nyquist).<br>3 – Controller design, analysis and specification of control systems based on root locus, frequency design, Bode Diagram. Stability criterion.<br>4 – PID control: methods of Ziegler-Nichols, pole-placement, etc. Basic techniques of project and compensation.<br>5 – Systems analysis in presence of disturbances, delays and several feedback loops.<br>6 – Digital PID design by emulation method. |
| **Recommended reading** | 1 – Texts and other material available in the course web page.<br>2 – K. Ogata, “Modern Control Engineering”, 3rd Ed., Prentice-Hall, 1997.<br>3 – B. C. Kuo, “Automatic Control Systems”, 7th Ed., Wiley, 1995.<br>4 – G. Franklin, D. Powell, A. Emani-Naeini, “Feedback Control of Dynamic Systems”, 3rd Ed., Addison-Wesley, 1994. |
| **Teaching methods** | Theoretical classes where the study methods are described and exemplified; Theoretical-practical classes where application exercises are solved; and Laboratory Practices. |
| **Assessment methods** | Written “open book” examination during regular exam periods (75%) and Practical Works (25%). |
| **Language of instruction** | Portuguese |

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## B – Description of individual course units

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|---|---|
| **Course title** | Industrial Automation |
| **Course code** | 911222 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Third |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | Casimiro Batista, Ana Lopes |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Students who complete this course will be able to:<br><br>Deal with hardware considerations (existence of different types of actuators and sensors).<br><br>Specify events and constrains in manufacturing systems.<br><br>Specify algorithms of local automation using formal methods.<br><br>Write programs for programmable controllers. |
| **Prerequisites** | NA |
| **Course contents** | 1 – Introduction to Automation<br>2 – Sensors and actuators<br>3 – Wiring logic.<br>4 – Pneumatics and hydraulics<br>5 – Programmable Logic Controllers. Grafcet.<br>6 – Industrial Communications. |
| **Recommended reading** | 1 – Texts and other material provided by the course lecturers.<br>2 –.Siemens – S7-22x manuals. |
| **Teaching methods** | Theoretical classes where the study methods are described and exemplified; Theoretical-practical classes where exercises are solved; and Laboratory Practices. |
| **Assessment methods** | Theoretical test. Laboratory works. |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Maintenance |
| **Course code** | 911226 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Third |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Ana Carla Vicente Vieira |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Provide the students with knowledge and procedural tools concerning buildings and industrial maintenance, namely the ability to understand concepts and the skill to apply usual maintenance management techniques and tools. |
| **Prerequisites** | NA |
| **Course contents** | Reliability;<br>Electromechanical systems maintenance and diagnosis methods;<br>Mechanical systems maintenance and diagnosis methods;<br>Electrical systems maintenance and diagnosis methods;<br>Industrial Instrumentation Maintenance;<br>Maintenance objectives and strategies;<br>Maintenance information circuits and documents for maintenance;<br>Maintenance service structure and staff organization;<br>Maintenance contracts and Outsourcing;<br>Maintenance management and control. |
| **Recommended reading** | Cardoso, António João Marques; Diagnóstico de Avarias em Motores de Indução Trifásicos (*in Portuguese*); Coimbra Editora; Portugal.<br>Higgins et al.; Maintenance Engineering Handbook; Edited by Lindley R. Higgins; McGrawHill.<br>Texts and other support material available during the course. |
| **Teaching methods** | Lectures (28 hours), problem resolution and practical exercises for project based learning (42 hours);<br>Small team projects development; Short research studies presentations and discussions for concepts application in the context of the course (incorporated in 87 hours of individual work). |
| **Assessment methods** | Written Test (compulsory);<br>Public presentations and discussion of some of the projects and short assignments (compulsory). |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Project |
| **Course code** | 911230 |
| **Type of course** | Annual |
| **Level of Course** | NA |
| **Year of study** | Third |
| **Semester/trimester** | Annual |
| **Number of credits** | 12 |
| **Name of lecturer** | NA |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Provide the students with knowledge and procedural tools concerning buildings and industrial maintenance, namely the ability to understand concepts and the skill to apply usual maintenance management techniques and tools. |
| **Prerequisites** | NA |
| **Course contents** | |
| **Recommended reading** | NA |
| **Teaching methods** | Lectures (28 hours), problem resolution and practical exercises for project based learning (42 hours);<br>Small team projects development; Short research studies presentations and discussions for concepts application in the context of the course (incorporated in 87 hours of individual work). |
| **Assessment methods** | Development and Presentation of a Practical Project |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Control of Electromechanical Devices (Branch: Industrial automatation) |
| **Course code** | 911234 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Third |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | Carlos Alberto Farinha Ferreira |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | To understand the circuits and components used in Power Electronics; to understand the functioning of industrial converters; to devise and design solutions for open and closed loop electro-mechanic drivers. |
| **Prerequisites** | Knowledge of physics (electromagnetic and mechanics), electrical circuits, electronics and control. |
| **Course contents** | 1 - Introduction: Power electronics versus linear electronics.<br>2 - Mechanical systems: modelling, transmissions, determination of mechanical parameters. Load demands.<br>3 - Power electronics components and converter topologies, dimensioning and command.<br>4 - Asynchronous machine drive chain: starting methods, command by variation of: V, VF, field orientation. Circuits used.<br>5 - Continuous current machine drive chain: position, velocity and torque control.<br>6 - More than one variable controlled systems. |
| **Recommended reading** | • Palma João, “Accionamentos Electromecânicos de Velocidade Variável”, Fundação Calouste Gulbenkian.<br>• Boldea, Ion, S.A. Nasar, “Electric Drives”, 1999.<br>• N. Mohan, T. M. Undeland, W. P. Robbins, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, Inc., 1989. |
| **Teaching methods** | Lectures and practical exercises (laboratorial). |
| **Assessment methods** | Test: 50%. Practice (laboratorial): 50%. |
| **Language of instruction** | Portuguese |

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## B – Description of individual course units

| | |
|---|---|
| **Course title** | Data Networks (Branch: Industrial automatation) |
| **Course code** | 911233 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Third |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | Gabriel Pires |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Provide knowledge of network architectures, data link and routing protocols and Ethernet based networks. Design and implementation of switching and routing local networks. Configuration of switching and routing equipment. |
| **Prerequisites** | Telecommunication fundamentals |
| **Course contents** | 1 - Layer architectures<br>2 - Data transmission<br>3 - Data link Layer<br>4 - Medium Access Control<br>5 - Protocols ICMP, ARP, IPv4 addressing;<br>6 - Local networks –Ethernet and 802 IEEE standards<br>7 - Network layer: Internet Protocol<br>8 - Case studies implementation<br>9 - Introduction to structured cabling 11801 standard |
| **Recommended reading** | - Data Communications, Computer Networks and Open Systems, Fred Halsall, Addison-Wesley;<br>- Data Communications and Networking, Behrouz A. Forouzan, McGraw-Hill;<br>- Ethernet: the definitive guide, Charles E. Spurgeon, O'Reilly;<br>- Lan Wiring, James Trulove, McGraw Hill; |
| **Teaching methods** | Lectures, practical exercises and lab experiments |
| **Assessment methods** | Written Test (60%), Lab work (20%), Case study implementation (20%)<br>(grading requirements: a minimum of 45% in the written Test and a minimum of 50% in the Labs and case study) |
| **Language of instruction** | Portuguese |

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## B – Description of individual course units

| | |
|---|---|
| **Course title** | Industrial Networks (Branch: Industrial automatation) |
| **Course code** | 911235 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Third |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Casimiro Batista |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Upon completion of the course, students should be able to:<br><br>Specify solutions for remote control of industrial devices.<br><br>Setup and operate a low level fieldbus solution (Profibus-DP)<br><br>Write programs for PLC's with high level programming languages (Step7). |
| **Prerequisites** | Industrial Automation |
| **Course contents** | Fieldbuses. OSI model. Fieldbuses architectures. Data link layer. MMS (Manufacturing Message Specification). Protocol solutions commercially available. Master/Slave with token. CSMA/CD(CR, DCR). Producer, distributor and consumer. Industrial networks. Topologies, services and profiles. Examples: Field – Profibus DP; Control – Profibus FMS; Command – ProfiNET. Monitoring and supervisory. HMI systems. SCADA systems. |
| **Recommended reading** | 1 – Texts and other material provided by the course lecturers.<br>2 –.Siemens – Step7 manuals.<br>3 – Stuart A. Boyer – "Supervisory Control and Data Acquisition" |
| **Teaching methods** | Theoretical classes including description and exemplification of study methods; Laboratory Practice |
| **Assessment methods** | Theoretical test. Laboratory projects. |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Industrial Robotics (Branch: Industrial automatation) |
| **Course code** | 911237 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Third |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Ana Lopes |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Provide the students with knowledge concerning the operation and management of robotic systems including theoretical aspects, technological issues, characteristics and operation, programming industrial robots, and industrial applications. |
| **Prerequisites** | Circuits, programming, electronics, digital systems and computer architecture and operating systems |
| **Course contents** | 1) Introduction<br>2) Spatial descriptions and transformations<br>3) Robot morphology<br>4) Robot kinematics<br>5) Introduction to trajectory generation<br>6) Industrial Vision |
| **Recommended reading** | [1] – Craig, John J. - Introduction to Robotics - Addison-Wesley Longman Publishing Co., 1989.<br>[2] - Fu, K. S. - Robotics : control sensing, vision and intelligence - McGraw- Hill Book Company, 1987. |
| **Teaching methods** | Lectures, practical exercises and lab experiments |
| **Assessment methods** | Written Test (60%), Lab work (40%)<br><br>(grading requirements: a minimum of 45% in the written Test and a minimum of 45% in the Labs) |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Embedded Systems (Branch: Industrial automatation) |
| **Course code** | 911236 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Third |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Ana Lopes |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Provide the students with skills related to the project and development of microcontroller-based systems (PIC family). |
| **Prerequisites** | C programming, digital systems, computer architecture |
| **Course contents** | 1) Introduction to PIC Familly Microcontrollers.<br>2) Interrupts (PIC18F458).<br>3) Timers/Counters (PIC18F458).<br>4) Serial Communication Modules (PIC18F458).<br>5) Introduction to Real-Time systems – Time constraints, and computational modules. |
| **Recommended reading** | [1] – Peatman, John B. – Design with PIC Microcontrolers, Prentice Hall, 1998.<br>[2] – Peatman, John B. – Embedded Design with PIC 18F452 Microcontrolers, Prentice Hall, 2003.<br>[3] - Buttazzo, G.C. - Hard Real-Time Computing Systems (2nd ed.) - Springer, 2004. |
| **Teaching methods** | Lectures, practical exercises and lab experiments |
| **Assessment methods** | Written Test (60%), Lab work (40%)<br>(grading requirements: a minimum of 45% in the written Test and a minimum of 45% in the Labs) |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Power Electronics (Branch: Energy) |
| **Course code** | 911223 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Third |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | Raul Monteiro |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | To provide the fundamentals of Power Electronics so that students acquire the knowledge and skills needed to analyze and design practical power electronic converters. |
| **Prerequisites** | Circuit analysis, Electronics and Electromagnetism. |
| **Course contents** | 1. Introduction and revision of fundamental concepts.<br>2. Passive and active components in power electronic converters.<br>3. Basic DC/DC switch mode converters.<br>4. DC/DC isolated switch mode converters.<br>5. DC/AC switch mode converters (inverters).<br>6. AC/DC converters (rectifiers).<br>7. EMI fundamentals and consequences in power converters.<br>8. Magnetics design. |
| **Recommended reading** | 1. Lesson slides and supporting materials (problems, laboratories)<br>2. *"Fundamentals of Power Electronics*" Robert W. Erickson, Dragan Maksimovíc, Kluwer Academic Publishers, ISBN 0-7923-7270-0.<br>3. *"Power Electronics – Converters, Applications and Design*", Mohan, Undeland, Robbins, John Wiley & Sons, ISBN 0-471-58408-8.<br>4. "*Principles of Power Electronics*", John Kassakian, Martin F. Schlecht, George C. Vergese, Prentice Hall, ISBN: 0201096897. |
| **Teaching methods** | Theoretical classes and theoretical-practical classes involving problem solving and laboratory demonstrations. |
| **Assessment methods** | Tests and exam. |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Electrical Machines (Branch: Energy) |
| **Course code** | 911224 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Third |
| **Semester/trimester** | First |
| **Number of credits** | 6 |
| **Name of lecturer** | José Fernandes |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Studying the steady state operating mode of asynchronous (special emphasis on speed control methods) and synchronous machines.<br>Upon completion of this course, including the compulsory laboratory experiments, the students should be able to operate these types of machines safely. |
| **Prerequisites** | Knowledge of energy conversion, electric circuit analysis and mathematics (trigonometry and complex numbers) |
| **Course contents** | 1 – Fundamentals of three-phase asynchronous machines<br>2 - The air gap magnetic rotating field and synchronous speed<br>3 - Circuit model, brake and generator mode of these machines<br>4 – Starting and speed control methods of these 3-phase machines<br>5 - Three-phase linear and 1-phase rotating asynchronous motors<br>6 – Fundamentals and field systems of synchronous machines<br>7 – Testing methods, curves and voltage regulation of alternators<br>8 – Alternators and synchronous motors connected to the grid<br>9 - The salient rotor synchronous machine<br>10 – Reluctance motors, step motors and DC brushless motors |
| **Recommended reading** | 1 – Notes prepared by lecturers<br>2 - “Máquinas Eléctricas”, A. E. Fitzerald – Charles Kingsley Jr - McGraw-Hill<br>3 - “Electric Machinery Fundamentals”, Stephen J. Chapman - McGraw-Hill<br>4 - “Máquinas Eléctricas” – Syed A. Nasar - Shaum McGraw-Hill |
| **Teaching methods** | Lectures including exposition of the course contents. Practical classes including exercise solving. Laboratory classes where the students have the opportunity to learn the functioning of some machines and perform related tests. |
| **Assessment methods** | Final mark= 2/3 Mark of a written exam + 1/3 Average mark of laboratory experiments |
| **Language of instruction** | Portuguese |

## B – Description of individual course units

| | |
|---|---|
| **Course title** | Control of Electromechanical Devices (Branch: Energy) |
| **Course code** | 911229 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Third |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Pedro Manuel Granchinho de Matos |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | - Develop dynamic models for the characterization of mechanical charges, electrical machinery, electronic converter and power supply;<br>- Design and analyze the performance of industrial drives and vehicles with electric traction, according to the specific requirements set by the load and source of power supply;<br>- Design and implement solutions to command and control systems operated by electronic power converters, based on electric rotary machines (direct current, synchronous and asynchronous). |
| **Prerequisites** | Basics of electrical machines and power electronics |
| **Course contents** | 1 Constitution of an electromechanical system;<br>2 Modelling of dynamic and stationary behaviour of mechanical systems;<br>3 Specific characteristics of electric vehicles;<br>4 Applications of control systems in electromechanical drives;<br>5 Power systems for electric traction;<br>6 Power chain in electric vehicles and hybrid electric vehicles; |
| **Recommended reading** | [1] – Granchinho de Matos, Pedro M. – Sebenta da disciplina de Controlo de Accionamentos Electromecânicos.<br>[2] – Palma, João C. P. – Accionamentos Electromecânicos de Velocidade variável, Fundação Calouste Gulbenkian 1999.<br>[3] – Husain , Iqbal, – Electric and Hybrid Vehicles, Design Fundamentals, CRC Press 2003.<br>[4] – Gillespie, Thomas D. – Fundamentals of Vehicle Dynamics, Society of Automotive Engineers. |
| **Teaching methods** | Theoretical classes describing and exemplifying the concepts provided and theoretical and practical classes for application of the concepts learned. |
| **Assessment methods** | Written exam.<br>Practical work with the use of software carried out during the semester. |
| **Language of instruction** | Portuguese |

ipt Instituto Politécnico de Tomar

## B – Description of individual course units

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|---|---|
| **Course Title** | Energy Distribution and Micro-generation (Branch: Energy) |
| **Course Code** | 911228 |
| **Type of Course** | One-semester course |
| **Level of Course** | NA |
| **Year of Study** | Third |
| **Semester/Trimester** | Second |
| **Number of credits** | 6 |
| **Name of Lecturer** | Mário Gomes |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Understand electrical current systems. Design, plan, execute and explore high-voltage transmission lines. Understand the various technologies used in distributed production and micro-generation. Design, plan, execute and explore the systems of interconnection of independent production units to electrical network. |
| **Prerequisites** | Basics of electrical machines, electrical installations and computing. |
| **Course contents** | 1 – Electrical Power Systems (EPS)<br>2 – Interconnection of two or more EPS.<br>3 – Unit system.<br>4 – Aerial and underground power transmission networks.<br>5 – Power transit studies.<br>6 – Distribution networks.<br>7 – Basics of distributed production, micro-generation and technical conditions for network interconnection. |
| **Recommended Reading** | Antonio Gómez Expósito, "Análisis y Operación de Sistemas de Energía Eléctrica", McGraw-Hill, 2002.<br>A. Manuel Matos, "Apontamentos da disciplina de Sistemas de Energia I", FEUP, http://paginas.fe.up.pt/~mam/SEE1.<br>J. Borges Gouveia, J. Pereira da Silva, J. Costa Matos, "Fluxo de Cargas", Sebenta da disciplina de SEE2 (4º ano – 1995/1996), FEUP.<br>Richard C. Dorf (Editor-in-Chief), "The Electrical Engineering Handbook", second edition, CRC Press, IEEE Press, 1997. |
| **Teaching Methods** | Lectures where case studies are presented to illustrate subject matters. Laboratory classes where students have the opportunity to solve exercises and practice with the PowerWorld software. |
| **Assessment Methods** | Written test (periodical test, examination or recovery exam) worth 75% and two laboratory assignments worth 25%. |
| **Language of Instruction** | Portuguese |

## B – Description of individual course units

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|---|---|
| **Course title** | Power Quality and Energy Management (Branch: Energy) |
| **Course code** | 911227 |
| **Type of course** | One-semester course |
| **Level of Course** | NA |
| **Year of study** | Third |
| **Semester/trimester** | Second |
| **Number of credits** | 6 |
| **Name of lecturer** | Ana Carla Vicente Vieira and Francisco Nunes |
| **Objectives of the course (preferably expressed in terms of learning outcomes competences)** | Provide the students with knowledge concerning power quality, energy policies, energy management and retrofitting programs; Portuguese and MIBEL markets, especially subjects related to the electrical sector and regulated pricing principles;. |
| **Prerequisites** | NA |
| **Course contents** | Electrical Power Quality and Management: National, European and International Directives, Standards and Regulations;<br>Terms and definitions related to power quality; Sources and fundamental principles of protection for power quality problems;<br>Monitoring power quality;<br>Terms and definitions related to energy management;<br>Energy policies; Portuguese and Iberian markets of electricity;<br>Electricity rate types and pricing principles; Portuguese electricity rates and bill calculations. Load Management; DSM;<br>Typical electric energy loads; Loads typical profiles;<br>Energy conservation and rational use; Energy management control systems; reactive power compensation;<br>Energy auditing; Retrofitting programs planning, scheduling and implementation; Economic analysis of energy related capital investments. |
| **Recommended reading** | Roger C. Dugan, Mark F. McGranaghan, H. Wayne Beaty; "Electrical Power Systems Quality"; McGraw-Hill.<br>Turner, Wayne C.; "Energy Management Handbook"; Fairmont Press, Inc.<br>National and international Standards and Regulations.<br>Texts and other support material available during the course. |
| **Teaching methods** | Lectures (28 hours), problem resolution, practical exercises and lab experiments (42 hours); Small team projects development (incorporated in 87 hours of individual work). |
| **Assessment methods** | Written Test (mandatory);<br>Team projects public presentations and discussion (mandatory). |
| **Language of instruction** | Portuguese |