BACHELOR OF ENGINEERING IN ELECTRICAL ENGINEERING

Main Language of Instruction:
French ☑ English ○ Arabic ○

Campus Where the Program Is Offered: CST

OBJECTIVES

The Bachelor of Engineering in Electrical Engineering aims to graduate students able to:

- Advance in their careers in various sectors at local, regional, and international levels while respecting ethical and professional conducts.
- Successfully pursue higher education in world-class universities.
- Become decision-makers, innovators, and leaders in their profession.

PROGRAM LEARNING OUTCOMES (COMPETENCIES)

- The ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- The ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- The ability to communicate effectively with a range of audiences.
- The ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, considering the impact of engineering solutions in global, economic, environmental, and societal contexts.
- The ability to function effectively on a team, where members provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- The ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- The ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

PROGRAM REQUIREMENTS

180 credits: Required courses (154 credits), Institution's elective courses (22 credits), Open elective courses (4 credits).
USJ General Education Program (26 credits - part of the above categories).

USJ General Education Program (26 Cr.)
10 additional credits are earned at the Department of Preparatory Classes
English (4 Cr.)
English Level A (4 Cr.)
Arabic (4 Cr.)
One Arabic Culture and Language course (2 Cr.) to be selected between:
Arabic Language and Media (2 Cr.)
Arabic Language and Arts (2 Cr.)
Arabic Language: Contemporary Novel, Cinema, and Theater (2 Cr.)
Business Law (2 Cr.)
Humanities (4 Cr.)
Business Ethics (4 Cr.)
Social Sciences (6 Cr.)
Project Management (4 Cr.)
One Institution's elective course (2 Cr.) to be selected between:
Work Ready Now (2 Cr.)
Entrepreneurship (2 Cr.)

Communication Techniques (8 Cr.)
Communication Skills (2 Cr.)
Multidisciplinary Project (2 out of the 6 credits of the course)
Final Year Project (4 out of the 16 credits of the course)

Fundamental Courses

Required Courses (154 Cr.)
Accounting (4 Cr.). Analog Electronics (6 Cr.). Business Ethics (4 Cr.). Business Law (2 Cr.). Communication Skills (2 Cr.). DC-AC Conversion (4 Cr.). DC-DC Conversion (4 Cr.). Digital Electronics (6 Cr.). Digital Systems and Control (4 Cr.). Dynamic Systems Modeling (4 Cr.). Electric Machines 1 (6 Cr.). Electric Machines 2 (4 Cr.). Electrification 1 (6 Cr.). Electrification 2 (4 Cr.). Electrotechnics (6 Cr.). English Level A (4 Cr.). Industrial Electronics (6 Cr.). Innovation and Design Thinking (2 Cr.). Linear Control (6 Cr.). Management (2 Cr.). Microprocessor Systems (4 Cr.). Modern Control (4 Cr.). Object-Oriented Programming (6 Cr.). Power Systems Analysis (4 Cr.). Project Management (4 Cr.). Renewable Energy (4 Cr.). Sensors and Instrumentation (4 Cr.). Signals and Systems (4 Cr.). Statistics (4 Cr.). Variable-Speed Drive Systems (6 Cr.)

Corporate Internships (2 Cr.) – During their studies, each student can complete two internships:
- A recommended labor internship of at least 4 weeks at the end of the third year of studies.
- A required technical internship of 6 to 10 weeks at the end of the fourth year of studies (2 Cr.).

Multidisciplinary Project (6 Cr.)
This project brings together students from different programs and/or options where each student participates in the execution of a task related to their field. It aims to provide hands-on design experience, strengthen their analysis capacity, and develop their communication skills and teamwork ability. In this project, students must apply the knowledge acquired throughout their academic years of study and provide a final product that went through all stages of design, modeling, analysis, testing and evaluation. A final report and an oral presentation are the main deliverables of the project.

Final Year Project (16 Cr.)
The final year project is carried out by groups of 2 to 4 students, aiming to deliver practical design experience in computer and communications engineering under the supervision and approval of a faculty member. Students must define the project, specify its objectives, perform a state of the art of the studies topic, establish the project specifications and select a design method. In this project, students must apply the knowledge acquired throughout their academic years of study and provide a final product that went through all stages of design, modeling, analysis, testing and evaluation. A final report and two oral presentations are the main deliverables of the project.

Institution's Elective Courses (22 Cr.)
Advanced Microcontroller Systems (4 Cr.). Artificial Intelligence (4 Cr.). Design of Mechatronics Systems (4 Cr.). Embedded Systems (4 Cr.). Entrepreneurship (2 Cr.). Fluid Mechanics (4 Cr.). Fuzzy Logic and Neural Networks (4 Cr.). Home Automation (4 Cr.). HVAC 1 (4 Cr.). HVAC 2 (4 Cr.). Industrial Engineering (4 Cr.). Industrial Process and Control (4 Cr.). Mixed-Signal IC Design (4 Cr.). Machine Learning (4 Cr.). Nonlinear Systems (4 Cr.). Numerical Methods (4 Cr.). Optimization (4 Cr.). PCB Design Fundamentals (4 Cr.). Power Generation (4 Cr.). Robotics (4 Cr.). Space and Micro/Nano Satellite Technologies (4 Cr.). System Identification (4 Cr.). Wheeled Robots (4 Cr.). Work Ready Now (2 Cr.).

Open Elective Courses (4 Cr.)
Arabic Culture and Language (2 Cr.). One Open elective course (2 Cr.)

SUGGESTED STUDY PLAN

Semester 1

Code	Course Name	Credits
020ELAES1	Analog Electronics	6
020MSDES1	Dynamic Systems Modeling	4
020ETCES1	Electrotechnics	6
020CPPES1	Object-Oriented Programming	6
020SYSES2	Signals and Systems	4
020STAES1	Statistics	4
	Institution's Elective course: Work Ready Now or Entrepreneurship	2
	Total	**32**

Semester 2

Code	Course Name	Credits
020TCOES2	Communication Skills	2
020ELNES2	Digital Electronics	6
020ME1ES2	Electric Machines 1	6
020IE1ES2	Electrification 1	6
020ELIES2	Industrial Electronics	6
020AULES2	Linear Control	6
	Open Elective: Arabic Language and Culture	2
	Total	**34**

Semester 3

Code	Course Name	Credits
020CCCES3	DC-DC Conversion	4
020SCNES3	Digital Systems and Control	4
020ME2ES4	Electric Machines 2	4
020IE2ES3	Electrification 2	4
020INDES2	Innovation and Design Thinking	2
020SMPES3	Microprocessor Systems	4
020GPRES2	Project Management	4
020CEIES3	Sensors and Instrumentation	4
	Institution's Elective course	4
	Total	**34**

Semester 4

Code	Course Name	Credits
020CCAES4	DC-AC Conversion	4
020ANGES4	English Level A	4
020CTMES4	Modern Control	4
020PRMES4	Multidisciplinary Project	6

020EVVES4	Variable-Speed Drive Systems	6
	Institution's Elective course	8
	Open Elective	2
	Total	**34**

Semester 5

Code	Course Name	Credits
020CMPES5	Accounting	4
020ETHES3	Business Ethics	4
020DROES5	Business Law	2
020STGES5	Corporate Internship	2
020MNGES4	Management	2
020ANRES4	Power Systems Analysis	4
020ERNES6	Renewable Energy	4
	Institution's Elective course	8
	Total	**30**

Semester 6

Code	Course Name	Credits
020PFEES6	Final Year Project	16
	Total	**16**

COURSE DESCRIPTION

020CMPES5 Accounting 4 Cr.

Topics covered include: Definition of Accounting, Accounting Process, Accounting Concepts, Classification of Accounts, Rules of Double Entry Accounting System, Rules of Journal, Current Assets, and Current Liabilities. Concepts of Cost Accounting, Advantages of Cost Accounting, Classification and Elements of Cost, and Preparation of Cost Sheet.

020SAMES4 Advanced Microcontroller systems 4 Cr.

Topics covered include: Introduction to embedded systems – Introduction to STM32 family of MCUs and STM32CubeIDE –Principles of schematic interpretation for embedded applications – Overview and practical exploration of MCU Peripherals: ADC, DAC, Advanced Timers, PWM, UART, I2C, SPI, DMA, SDIO, USB – Introduction to Real Time Operating System (RTOS) – Introduction to machine learning on MCUs and TinyML.
Prerequisite: Microprocessor Systems (020SMPES3)

020ELAES1 Analog Electronics 6 Cr.

This course covers the main low-power electronic components: 1) P-type and N-type semiconductors – P-N junction; 2) diodes: characteristics and application circuits (clipping, rectification…), Zener diode (regulation), Light-emitting diode. 3) Bipolar transistor: DC operation (I-V characteristics, Biasing, Load line), AC operation (amplifier circuits), synthesis of amplifier circuits, Bipolar transistor as switches. 4) MOSFET transistors: I-V characteristics, resistive operation and amplification. 5) Operational amplifier (OA): behavioral model and imperfections, application circuits (Inverting/Non-inverting amplifiers, Integrators, Voltage Follower, Active filters). 6) Comparator: characteristics, performance & limitations, applications.
Prerequisite: Linear Electrical Systems and Networks (020SRLNI4 or 020SRLCI4)

020IA2ES4 Artificial Intelligence 4 Cr.

This course aims to study artificially intelligent agents. It portrays several methods of implementing these agents: from simple reflex agents to utility-based agents as well as learning agents. It first covers greedy and A* search, the implementation of games through the Minimax and Expectimax algorithms, Markov Decision Processes (MDP) and Reinforcement Learning (RL). It then introduces Machine Learning (ML) algorithms with some applications.

020ETHES3 Business Ethics 4 Cr.

This course is interactive in nature. It includes readings and analysis of basic texts, moments of reflection and debate, awareness of the state-of-the-art in the region, studies of authentic international organizational documents, role plays and projects for a more pragmatic analysis. It is aimed at students destined to work in public or private companies and in all fields. Its objective is to create awareness for the need of ethics, which is becoming inescapable today, given current trends towards sustainable development, the dissemination of information to stakeholders and transparent competition. It also offers prospective engineers the opportunity to understand business issues from an analytical perspective and to distinguish themselves by their professionalism and informed attitude about ethics. Finally, students will be more alert to the entrepreneurial approaches and the ethical reflection that accompanies it.

020DROES5 Business Law 2 Cr.

This course provides an overview of the legal framework governing commercial activities and business entities. It covers fundamental concepts related to commercial transactions, the status of merchants, and the regulations governing business establishments.

020TCOES2 Communication Skills 2 Cr.

Communication is of high importance for an engineering student. Indeed, whether in academic or professional activities, transmitting information is a powerful tool for convincing and even influencing others. Communication is unavoidable, but it comes with many errors and risks that should be avoided. Otherwise, the reception of the information may be disturbed and misunderstood. This course offers students the knowledge of essential basic rules of main ways of communication (written, verbal and non-verbal) and makes them aware of the errors to be avoided.

020STGES5 Corporate Internship 2 Cr.

The corporate internship is a learning opportunity for students to: apply the knowledge they acquired during earlier coursework in a professional environment - acquire professional skills in addition to the theoretical and practical training – experience situations of human relationships that occur in the different environments where engineers may work - acquire experience and knowledge that facilitate future professional integration.

020CCAES4 DC-AC Conversion 4 Cr.

In this course, different topologies of DC-AC switch-mode power converters are presented: single and three-phase inverters, two and multilevel structures. A detailed analysis starting from the possible configurations, then the establishment of the mathematical equations, the waveforms and the input-output features, and the selection of the semiconductor devices and all other components is elaborated for each topology. Rating criteria based on the evaluation of the voltage and current stresses are elaborated.
In addition, different Pulse-Width-Modulation (PWM) control strategies are introduced and studied: carrier-based PWM, space-vector modulation, pre-calculated modulation, sigma-delta and delta modulations. Numerical simulations are performed to verify the theoretical concepts.
Prerequisite: DC-DC Conversion (020CCCES3)

020CCCES3 DC-DC Conversion 4 Cr.

In this course, different topologies of DC-DC switch-mode power converters are presented. Two categories of converters are studied: choppers for DC-motor drives and DC power supplies. A detailed analysis starting from the possible configurations, then the establishment of the mathematical equations, the waveforms and the input-

output features, and the selection of the semiconductor devices and all other components is elaborated for each topology. Rating criteria based on the evaluation of the voltage and current stresses are elaborated.
Prerequisite: Industrial Electronics (020ELIES2)

020CSMES4 Design of Mechatronic Systems 4 Cr.

This course offers a comprehensive understanding of mechatronics and microcontroller systems, emphasizing the integration of mechanical components, electronics, and data-driven control. Students will explore topics such as numbering systems, microcontroller architecture, assembly language programming, A/D and D/A conversion, parallel I/O, programmable timer operation, and the interfacing of sensors and actuators. Through theoretical knowledge, students will develop the skills required to design and implement mechatronic systems for various applications. Furthermore, they will collaboratively engage in a team project focused on applying these skills to real-world scenarios.
Prerequisite: Sensors and Instrumentation (020CEIES3).

020ELNES2 Digital Electronics 6 Cr.

Topics covered include: Introduction to digital integrated circuit technology. Digital integrated circuits using MOS transistors, CMOS characteristics, fundamental building blocks, transistor level design of CMOS logic gates circuits, interfacing digital integrated circuits. Data converters basics: sampling, quantification, coding, analog switches, Overview of Analog to digital converter (ADC) and Digital to analog converter (DAC) circuits (Resistive Weights, R/2R, SAR, Flash). Introduction to Memory Devices: terminology, architecture, ROM, SRAM, DRAM, Memory assembly.
Prerequisite: Analog Electronics (020ELAES1)

020SCNES3 Digital Systems and Control 4 Cr.

This course is divided into three main parts. The first part discusses discrete system modeling, Z-transform, discrete transfer functions and discrete systems stability. The second part develops the design of digital controllers (discretized classic controllers, dead-beat control). The final part presents the implementation of digital controllers using embedded systems and real time simulations of a system in closed loop.
Prerequisites: Linear control (020AULES2), Signals and systems (020SYSES2)

020MSDES1 Dynamic Systems Modeling 4 Cr.

The aim of this course is to introduce and train students to the crucial importance of modeling and analysis in the industry nowadays that leads to performance improvement, better time management and manufacturing cost reduction of a given product. These goals are taught through examples of electrical, mechanical, thermal, and complex systems. Pre-sizing, modeling, analysis of operation and performance are performed through simulations using the advanced software MATLAB/Simulink. This course initiates engineering design to students through iterative improvements, feasibility study and process optimization before the usual industrial prototyping.
Prerequisite: MATLAB (020MATNI4)

020ME1ES2 Electric Machines 1 6 Cr.

Topics covered include: Construction and operation of rotating machines in steady state. Electromechanical conversion, rotating magnetic field, dc machines, induction machines and synchronous machines operating as either a generator or a motor. Equivalent circuits, tests, and determination of the parameters of the equivalent circuits. Use an equivalent circuit to predict the performance of a machine with reasonable accuracy. Electromagnetic torque and shaft torque. Torque-speed characteristics, efficiency, nameplate, and rated values. Introduction to variable speed drives.
Prerequisite: Electrotechnics (020ETCES1)

020ME2ES4 Electric machines 2 4 Cr.

This course aims to extend the concepts of electrical engineering according to four axes: I) Transformers: Special transformers – Transformers in unbalanced mode – Transformers in transient mode – Parallel operation of transformers. II) DC machines: DC machines in transient mode - Application in unsaturated transient conditions. III) Induction Machines (IM): Generator and brake operation of a three-phase IM - Special types of IM: Deep-Bar

Squirrel-Cage, Double-Cage rotors and Single-Phase IM – Modeling of the induction machine in transient mode and applications. IV) Synchronous machines: Rotating fields theory – Transient modeling of synchronous machines: with smooth poles, with salient poles, with or without damper bars – Applications.
Prerequisite: Electric machines 1 (020ME1ES2)

020IE1ES2 Electrification 1 6 Cr.

Topics covered include: Earthing System, low voltage electrical equipment, Overview of IEC 60364 and NFC-150 standards, low-voltage electrical equipment, control and protection equipment, electrical schemes, surge arresters. Photometry and lighting, photometric terms, luminous efficiency, different types of lamps, lighting of the premises, lighting standards, the different types of lighting, photometric class, photometric curve & Kruithof's rule. Lighting project: Lighting of closed areas, type of luminaire, calculation, UGR. Public lighting and projectors, functional lighting, residential lighting, projectors. Dialux, interface overview, model a project. Standards and AutoCAD, electrical Installation standards, definition of voltage ranges, the different ranges of voltage that exist, electrical protection classes, protection class "IP", mechanical Impact protection rating "IK", fire resistance rating, luminaire – incandescent wire test, the Bathrooms, Standards for electrical appliances in the bathroom, establishing an equipotential link. AutoCAD. Low voltage installation: ground connection diagrams, earth connections, Connecting the transformer neutral to the earth, Different types of electrical accidents, Ground connection diagrams. Power and minimum cross-section of a conductor, Installed Power, Absorbed Power, estimated installed power, Utilization Power, Choice of transformer power rating, Practical determination of the minimum cross-section of a conductor, voltage drop.
Prerequisite: Electrotechnics (020ETCES1).

020IE2ES3 Electrification 2 4 Cr.

Topics covered include: Short circuit current: three-phase short-circuit current at the secondary of a transformer MV/LV, three-phase short-circuit current at any point in a LV installation. Electrical panels & cables: description of electrical panels, types and forms of tables, composition of electrical panels, types of electrical cables, thermal stress of the cables, selection of protective devices. Disturbances due to harmonics: harmonics, reminder of the Fourier Series, harmonic pollution, the effects of harmonics and resonance, IEC Standards in the fight against harmonics, basic solutions to attenuate harmonics, measurement of harmonics in electrical networks. Software for the design and sizing of LV electrical installations: ECODIAL, draw a single-line diagram, make calculations, and make reports. Extra low voltage systems: telephone and TV system, residential telephone, telephone line, business phone system, VoIP, television and antennas, RG cables. Fire alarm system: operation and components, Addressable and conventional systems, fire alarm cable, maintenance, and evacuation plan. Surveillance System – CCTV: operation and advantages of CCTV, schematic diagram and components, CCTV cabling, maintenance. Lightning protection system: lightning, lightning rod characteristics and operation, the different types of lightning rods, differences between lightning rod and surge arrester, rules to follow and isolation spark plugs.
Prerequisite: Electrification 1 (020IE1ES2).

020ETCES1 Electrotechnics 6 Cr.

The aim of this course is the study of three-phase electrical networks in balanced and unbalanced steady-state sinusoidal operation as well as single-phase and three-phase transformers. The course covers the dielectrics, conductors, magnetic materials used in electrotechnics, the operating and modeling of linear and nonlinear magnetic circuits without and with flux leakage and the effect of the airgap.
It also covers the modeling of three-phase balanced and unbalanced electrical networks operating in a sinusoidal regime by the method of the single-phase star equivalent scheme and the symmetrical components method. Finally, the principles of operation of single-phase and three-phase transformers are studied in order to establish their equivalent circuits and predetermine the values of the voltages, currents, powers, efficiency at no-load, short-circuit and load operations.
Prerequisites: Electromagnetism (020EMENI3 or 020EMECI3), Linear electrical systems and networks (020SRLNI4 or 020SRLCI4)

020SEMES3 Embedded Systems 4 Cr.

Topics covered include: Embedded systems: Introduction, motivation and applications – Types of the embedded systems – Integration and implementation levels – Variable types – Fixed and floating point variable formats –

Schematics and PCBs – FGPA: Introduction, Basic Logic Element (BLE) architecture, input/output – Introduction to Quartus Prime and Altera FPGA – VHDL: Introduction, basics, combinatorial and sequential behavior, process and clocks, advanced concepts – Introduction to co-design: link between the hardware and the software – NIOS II processor creation and programming.
Prerequisites: Digital Systems Design (020TEDNI4 or 020TEDCI4), Programming 1 (020IF1NI2 or 020IF1CI2)

020ANGES4 English 4 Cr.

This course is designed to develop critical thinking, reading, oral and writing skills. It focuses on synthesizing sources producing a research paper and defending it in front of an audience. Emphasis is on the analytical reading of different text types required in the courses as well as on synthesis from a variety of sources to produce a written text and present it orally.

020ENTES1 Entrepreneurship 2 Cr.

Topics covered include: Design thinking, Problem tree, Business Model Canvas, Presentation – Value Proposition Canvas, Customer segmentation (Product-market fit), Competitive analysis, Go2market strategy, Presentation – Basic budgeting and financial figures, Pitch deck, Presentation.

020PFEES6 Final Year Project 16 Cr.

The final year project is a culminating major engineering design experience carried out by groups of 2 to 4 students under the supervision of a faculty member. Students must define the project, specify its objectives, perform a state of the art of the studies topic, establish the project specifications and select a design method. In this project, students must apply the knowledge acquired throughout their academic years of study and provide a final product that went through all stages of design, modeling, analysis, testing and evaluation. A final report and two oral presentations are the main deliverables of the project.
Prerequisite: Validate 150 credits

020MEFES2 Fluid Mechanics 4 Cr.

Topics covered include: The fundamental elements for understanding incompressible fluid flow. Characteristics of fluids - Kinematics - Conservation equations - Study of viscous fluids – Dimensional analysis and similarity - Flow regimes - Laminar and turbulent flows in pipes. Euler and Bernouilli theorem - Navier-Stokes equations. Dimensional analysis applying the PI theorem.
Prerequisite: Mechanics 2 (020MC2CI3 or 020MC2NI3)

020LFLES5 Fuzzy Logic and Neural Networks 4 Cr.

In this course, two intelligent techniques for data processing drawn from complex and imprecise environment are presented and studied. Fuzzy Logic theory is based on the empirical aspect of the human reasoning, and is used in the manipulation of imperfect, imprecise, or approximate knowledge. It allows the modeling and processing of very complex systems in which, for example, human factors are present. Theory and applications concerning fuzzy logic have existed for more than fifty years. They cover several fields such as artificial intelligence, identification and control of dynamic systems, automatic decision-making in complex systems, and fault diagnosis in industrial processes. On the other hand, Artificial Neural Networks are based on the biological aspect of the human brain. They are currently widely applied in various sectors such as telecommunication systems, automation, robotics, image processing and recognition, artificial intelligence, medicine and economics.

020DOMES3 Home Automation 4 Cr.

Topics covered include: Introduction to Home Automation. Communication mode: Dry contact, Serial, Infrared and TCP-IP. Protocol: Wired and Wireless, Dedicated and Universal. Type of control: Lighting, electrical curtains, HVAC and Audio video equipment. Interface with other systems: Building management systems (BMS), Fire Alarm, Intrusion, CCTV and intercom. Internet of things (IOT). User Interface: Binary input, Wired Keypads, Wireless remote control, Touch screen and Mobile / Tablet applications. Concept of electrical installation relative to home automation complete with the relative electrical panel. Load schedule with the number of circuits and type of control. Home Automation devices. KNX Protocol. ETS software. Concept of typical project (requirement and recommendations).

020CL1ES3 HVAC 1 4 Cr.

Topics covered include: Thermal Comfort: Thermal and Hydrothermal Exchange - Interior Basic Conditions - Exterior Basic Conditions - Comfort Elements: Activity, Clothes, Hygrometry, Radiation, Temperatures - Psychometric Chart: Calculation and dimensioning of heating, Cooling, Humidifying, Dehumidifying systems for interior ambient - Load Estimation for Heating taking into account the Impacts of Ventilation, Wall insulation, Glazing treatment, Lighting and Equipment heating production, etc. - Central Heating using Hot Water: Presentation, Design and sizing of radiators, Fan-coils, Floor heating, Convectors, Pipes, Pumps, Boilers, Burners, Domestic hot water, Fuel tanks, Chimney, etc. - Heating with Hot Air: Production of hot air, Air handling unit, Fan coil unit - Presentation, Design and sizing using the psychometric chart of heating coils, Humidifiers, Air filters, Fans, Mixing box.
Prerequisites: Fluid Mechanics (020MEFES1) or Fluid Mechanics 1 (020MF1ES1), Thermodynamics 2 (020TH2CI4) or Introduction to Heat Transfer (020ITCNI3 or 020THENI3).

020CL2ES4 HVAC 2 4 Cr.

Topics covered include: Heat pump – Mollier diagram – Environmental issues related to cooling fluids (Ozone and global warming) and new fluids – Summer thermal balance sheet – Cold battery and air evolution on cold batteries – Direct and indirect expansion air conditioning modes – Low and high-speed duct systems – Single and double flow and variable air flow.
Prerequisite: HVAC 1 (020CL1ES3).

020ELIES2 Industrial electronics 6 Cr.

This course introduces students to the expanding field of power electronics in the domain of industrial applications. It is articulated around three main topics: first, the characteristics of power semiconductor devices (ideal vs practical), which are used as switches to perform the power conversions from ac-dc, dc-dc, dc-ac and ac-ac, then an in-depth study of the operation, analysis, and design of single-phase and three-phase thyristor-based power rectifiers. This main part is validated by workshops using MATLAB/Simulink, as well as a set of lab experiments. Finally, an application related to variable speed systems, and based on power-rectifiers is developed.
Prerequisite: Analog electronics (020ELAES1)

020GINES5 Industrial engineering 6 Cr.

This course provides a general idea of the world of Industrial Engineering that electrical engineers need to know about. It provides a comprehensive view on the effect of labor on productivity, the effect of information system on the flow of work, the optimum experimental design and optimizing processes.

020PRNES4 Industrial process and control 4 Cr.

Topics covered include: Programmable Logic Controllers (PLC) – Distributed Control Systems (DCS) – Supervisory Control And Data Acquisition (SCADA) – Human Machine Interface (HMI) – Remote Terminal Unit (RTU) - Fieldbus (MODBUS, PROFIBUS, PROFINET, HART) – CPU memory (executive, system, data, program) – Memory types (RAM, ROM, EPROM, EEPROM) - Data type (input, output, digital, analog) – SCADA architecture (field level, automation level, management level) – Intelligent Electronic Devices (IED) – Communication (message, sender, receiver, master, slave, serial, parallel) – Transmission (simplex, duplex, point to point, multipoint, guided, unguided) – Topology (mesh, star, bus, ring, hybrid) – Transmission media (twisted pair, coaxial, patch cable, crossover cable, fiber optic) – Data coding – Operational Block (OB) – Function (FC) – Function Block (FB) – DataBlock (DB) – Scan cycle – Interrupt – MODBUS data types (discrete input, coil, input register, holding register).

020INDES2 Innovation and Design Thinking 2 Cr.

This course is designed to cultivate a creative mindset and the practices essential for driving innovation. Students will explore the nature of creativity and the sources of groundbreaking ideas. The course emphasizes that fostering the belief in one's creative potential is the first step toward becoming an innovative thinker and leader. It also covers strategies for enhancing creative confidence and empowering others to adopt this mindset. Additionally, students will be introduced to the design thinking process, a proven methodology for systematic innovation. The course guides students through each stage of design thinking, from identifying needs and building empathy to generating insights, prototyping, and experimenting. Ultimately, the course focuses on cultivating an innovative mindset within professional environments and learning how to inspire and lead others in the pursuit of creative solutions.

020AULES2 Linear Control 6 Cr.

This course introduces important basic concepts in the analysis and design of control systems. It is divided into two parts. The first covers transient and steady-state response analysis of 1st and 2nd order linear systems, as well as frequency-response analysis using Bode, Nyquist and Nichols diagrams. It is followed by an introduction to closed-loop versus open-loop control systems leading to a stability analysis. The second part covers the analysis and design of linear control systems using different types of controllers. The design of such controllers is presented using frequency-response methods, analytical calculations, and experimental techniques. The whole is validated with exercises and workshops using MATLAB/Simulink, as well as a set of lab experiments leading to the design and test of a linear control system.
Corequisite: Analog Electronics (020ELAES1) or Prerequisite: Electronics (020ELCES1).

020MLRES4 Machine Learning 4 Cr.

Machine learning (ML) is a subfield of Artificial intelligence. It is the science of making the machine learn by examples. The goal of ML is to make a computer that can learn from examples autonomously. The main research topics in ML include: Computer Vision (CV) and Natural Language Processing (NLP) and precision medicine for personalized treatments. The main goal of this course is to acquire a basic understanding of ML algorithms as well as hands-on ML engineering experience with regards to its application to realistic datasets through Python implementations that make use of state-of-the-art libraries such as Scikit-learn, Tensorflow and Keras.

020MNGES5 Management 2 Cr.

This course is a study of management theories, emphasizing the management functions of planning, decision-making, organizing, leading and controlling.

020SMPES3 Microprocessor Systems 4 Cr.

Topics covered include: Difference between microprocessors, microcontrollers and DSP – microprocessor architecture; realization of a basic board – Microcontroller architecture (PIC 18F2520) – Implementation of ROM, RAM and DATA EEPROM memory – special registers – addressing modes – inputs/outputs – interrupts – timers – analog to digital converter – asynchronous serial port – read from program memory – comparators – watchdog – sleep mode – Low Voltage Detect – oscillator – configuration words – Design, simulation and realization of microprocessor systems.
Prerequisite: Digital Systems Design (020TEDNI4 or 020TEDCI4)

020CCIES4 Mixed-Signal IC Design 4 Cr.

This course introduces the use of an industrial EDA Software tool to acquire computer-Aided Design skills in the field of Integrated Circuit Design. Topics covered include: IC Design Flow, Fabrication Technology and Packaging. Multi-stage Amplifiers, Current mirrors and Active Loads, Basic Biasing concepts, Differential signaling, Operational Amplifier Transistor-Level Design, Filters, Sampled circuits, Buffers, Frequency response of analog feedback circuits, Introduction to stability of feedback amplifiers, Simulation and Evaluation of the electrical performance of ICs using EDA Software. Introduction to Noise and Linearity in Electronics.
Prerequisite: Digital Electronics (020ELNES2)

020CTMES4 Modern Control 4 Cr.

Topics covered include: Modeling a multi-variable system, interpretation, and linearization. Response and matrix transfer. Realization in controllability, observability, and Jordan forms. Controllability, and its properties, partial controllability. Observability and its criteria. Minimum implementation, stabilization, and detection. Directions of the poles and zeros, simplification. Pole placement control, error integration, and observers. Optimal quadratic control (LQG): introduction, Riccati equation, Kalman filter, validity conditions. Guided mini project: modeling, design, and simulation.
Prerequisite: Linear control (020AULES2)

020PRMES4 Multidisciplinary Project 6 Cr.

This project brings together students from different programs and/or options where each student participates in the execution of a task related to their field. It aims to provide hands-on design experience, strengthen their

analysis capacity, and develop their communication skills and teamwork ability. In this project, students must apply the knowledge acquired throughout their academic years of study and provide a final product that went through all stages of design, modeling, analysis, testing and evaluation. A final report and an oral presentation are the main deliverables of the project.

020SNLES5 Nonlinear Systems 4 Cr.

This course is divided into two parts. The first part presents two analysis methods of nonlinear systems. The first method, characterized by its simplicity, is based on the describing function concept in the frequency domain. It makes use of basic elements already seen in linear systems analysis and control, which are extended to the nonlinear case. The second method is more rigorous and uses the concept of state variables and phase plane in the time domain. The stability theory of nonlinear systems study will be presented in both frequency and time domains (Loeb criterion, Lyapunov theorem). In the second part of the course, two nonlinear time-domain control techniques are presented: the sliding-mode control known by its robustness, and the feedback linearization control characterized by its precision. The advantages and drawbacks of these two control methods with respect to conventional techniques will be underlined. Their application in the control design of nonlinear industrial processes will also be illustrated.

020MENES1 Numerical Methods 4 Cr.

Topics covered include: Introduction to numerical calculation, error analysis and propagation, numerical software, interpolation and approximation, integration and differentiation, numerical solution to differential equations, finite difference method, matrices, resolution of linear systems, matrix decomposition, eigenvalues and eigenvectors, non-linear system of equations.
Prerequisites: [Linear Algebra (020ALNNI2) or Algebra 1 (020AL1CI2)] and [Differential Calculus (020CDFNI4) or Analysis 2 (020AN2CI3)].

020CPPES1 Object-Oriented Programming 6 Cr.

Topics covered include: C/C++ syntax: typed variable declarations, basic I/O, expressions, implicit and explicit type conversion, conditional branching, for and while loops, functions and prototypes, parameter passing and overloading. Arrays, strings, cyclic dependency resolution, references, pointers and manual memory management. Deep copy and smart pointers. The object-oriented paradigm: abstraction, encapsulation, inheritance and polymorphism. Definition of classes, constructors, destructors, attributes, methods, the "static" keyword, access modifiers and operator overloading. Development environment with VS Code. Compiling with CMake. Code versioning with git and github.
Prerequisite: Programming 2 (020IF2CI3 or 020IF2CI3)

020OPTES5 Optimization 4 Cr.

This course introduces optimization techniques tailored for electrical engineers. Students will learn to identify electrical engineering problems and formulate them as optimization problems by selecting appropriate objective functions and constraints and applying optimization algorithms to find optimal solutions. Topics include linear and nonlinear optimization, convex optimization, and heuristic methods.
Emphasis is placed on understanding mathematical foundations, algorithmic implementations, and practical applications in electrical engineering systems. Besides, students will learn to interpret and assess optimization results by comparing different optimization algorithms in terms of convergence speed, computational burden, and ability to find local/global minimum.

020PCBES5 PCB Design Fundamentals 6 Cr.

This course introduces the fundamentals of designing printed circuit boards (PCBs) using industrial EDA software tool. Students will learn the key concepts, tools, and techniques used in PCB design, including schematic capture, component placement, routing, design rules, and manufacturing considerations. The course also covers topics such as signal integrity, parasitic, coupling, controlled impedance and power distribution. Additionally, this course includes a project realization of a complex circuit using Proteus software.
Prerequisite: Digital Electronics (020ELNES2)

020PENES4 Power Generation 4 Cr.

The Power Generation course is designed to provide students with a deep insight into the various technologies and methodologies used to generate electrical power. It encompasses theoretical principles, practical applications, and the environmental considerations associated with power generation, specially the steam and gas power cycles. The course also covers the operating conditions of steam and gas cycles at design conditions and partial loads, as well as the economic and environmental aspects.
Prerequisite: Fluid Mechanics (020MEFES1) or Fluid Mechanics 1 (020MF1ES1).

020ANRES4 Power Systems Analysis 4 Cr.

This course introduces the students to the physical aspects of the electric transmission lines. It shows how to determine their equivalent mathematical model and calculate their structural parameters. Based on such model, performance study is elaborated in both permanent and transient regimes (power losses, voltage regulation, power factor, transient overvoltage). Compensation techniques to improve the power factor are presented. Numerical methods and algorithms for calculating the power flow are also explained and applied. Short-circuit analysis is detailed, and power system stability following short-circuit disturbance is discussed. In addition, methods for the selection of isolators and protection devices are exposed. Finally, the benefits of DC transmission systems and its technical aspect are presented.

020GPRES2 Project Management 4 Cr.

This course focuses on equipping students with the essential skills and techniques needed for successful project management, ensuring projects are completed on time, within budget, and to a high standard. It aims to teach students effective strategies for managing project budgets, schedules, and quality, while exposing them to a variety of practical tools and methodologies for overseeing projects they are currently working on or will be responsible for in the future.

020ERNES6 Renewable Energy 4 Cr.

This course offers a comprehensive exploration of the latest advancements in renewable energy technologies and their diverse applications. It aims to foster an understanding among students about the potentials and unique characteristics of renewable energies, particularly in the area of electricity generation. The course addresses key questions such as the nature of these energy resources, methods for their capture and transformation, and the various forms in which they can be utilized.
Throughout the program, students will explore specific topics, including the Principles of Solar Radiation (covering the solar spectrum, impact of geometry, and atmospheric attenuation), Solar Thermal and Solar Electric Photovoltaics (PV) with a focus on applications, PV System Components, Design, Selection & Sizing, as well as the Basics of Solar Energy System Engineering Economics. The program also explores the origin and power of wind, historical perspectives on wind turbines, Wind Energy System Components, Turbine Design & Control, Electrical Aspects of Wind Turbines, and the essentials of Wind Energy System Selection & Sizing, along with Wind Energy System Engineering Economics Basics. This comprehensive examination equips students with the knowledge and skills needed to navigate the complex landscape of renewable energies.

020ROBES5 Robotics 4 Cr.

This course aims to introduce some theoretical and practical fundamentals of robotics engineering related to electrical and mechanical domains. The concept of robotics is introduced starting from the sensors, actuator and closed loop representation, going through dynamics and kinematics equations, and reaching control of robots using linear, non-linear, and adaptive controllers. Topics covered include: Concepts of dynamic response related to vibration and motion planning. The principles of operation of various actuators, pneumatic, magnetic, piezoelectric, linear, stepper, etc. Advanced feedback mechanisms using software executing in an embedded system. The concepts for real-time processor programming. Image processing and artificial intelligence. Neural networks and advanced controllers, along with their implementation using microcontrollers and/or software based (MATLAB, LabVIEW, etc.).

020CEIES3 Sensors and Instrumentation 4 Cr.

This course provides a general review of the main characteristics of a sensor (sensitivity, time response delay, measurement errors). Several types of sensors, such as optical sensors, temperature sensors, tachometric sensors, position and displacement sensors, force, weight and torque transducers, are described and studied in detail.
Prerequisite: Electronics (020ELCES1) or Digital Electronics (020ELNES2).

020SYSES2 Signals and Systems 4 Cr.

This course covers the basic concepts of signal processing and continuous and discrete systems such as the Fourier transform, distributions, Fourier series decomposition of periodic signals, Parseval's theorem, linear and invariant systems, linear filtering of continuous signals, linear and nonlinear distortions, sampling, Z transform, discrete time Fourier transform, truncation windows, discrete Fourier transform (DFT), Fast Fourier (FFT), recursive and non-recursive digital filters, synthesis of recursive and non-recursive filters.
Prerequisite: Differential calculus (020CDFNI4) or Analysis 2 (020AN2CI3)

020SSTES4 Space and Micro/Nano Satellite Technologies 4 Cr.

Topics covered include: Micro/nano satellite mission, orbits design and analysis, subsystem scheme, micro/nano satellite configuration design, system performance determination and analysis, reliability and safety analysis technical processes of the satellite development, attitude system determination and control, design of the micro/nano satellite integrated electronic system, architecture of micro/nano satellite integrated electronic and relevant technical specifications, concept of micro/nano satellite testing description,, ground station types and related software's, STK tracker software, design and implement (tabletop) a nanosatellite type Cubesat 1U using commercial components and boards.
Prerequisites: Analog Electronics (020ELAES1) and Mechanics 1 (020MC1NI1 or 020MH1NI1)

020STAES1 Statistics 4 Cr.

Topics covered include: Sampling distribution - Estimation by confidence intervals, estimation by maximum likelihood, and estimation by the method of moments - Hypothesis tests for the mean, the variance, the proportion, independence and fitting to a distribution - Simple and multiple linear regression - Non-parametric tests.
Prerequisite: Probability (020PRBNI4) or Algebra 3 (020AL3CI4).

020IPRES5 System Identification 4 Cr.

Topics covered include: Course introduction. Plants and systems models: type of models and representation methods. Identification of nonparametric models in the time and frequency domains: correlation method, Fourier analysis, spectral analysis, closed loop identification. Pseudo ransom binary signal: properties and design for identification purposes. Parametric model's identification: least squares technique, recursive, weighted, instrumental variables, etc. MATLAB Identification Toolbox. Workshops using MATLAB/Simulink. Experimental identification and control of a linear system.
Prerequisite: Digital systems and control (020SCNES3)

020EVVES4 Variable Speed Drives 6 Cr.

This course aims to introduce the multiple control possibilities offered by variable speed drives for the three main types of motors in the electrical engineering field. Topics covered include: I) Variable speed DC machine: Four-quadrant operation, Four-quadrant three-phase rectifier with no circulating current, Speed control using cascaded loops, Current loop and speed loop. II) Variable speed induction machine: Steady-state equivalent circuit at high frequencies, Torque harmonics, Scalar control of a squirrel-cage induction machine, Vector control of a squirrel-cage induction machine, introduction to DTC control of an induction machine. III) Variable speed synchronous drives: introduction to the scalar control and the vector control of synchronous drives. All three case studies are simulated and validated using Matlab/Simulink software.
Prerequisites: Linear control (020AULES2), Electric machines 2 (020ME2ES4)

020CM2ES4 Wheeled Robots 4 Cr.

This course provides in-depth coverage of wheeled mobile robots. Topics covered include (i) nonholonomy and integrability of kinematics constraints; (ii) modelling: kinematics, dynamics, and state-space representation; (iii)

nonlinear control strategies (open-loop and closed-loop), and (iv) simulation using the virtual wheeled mobile robots' laboratory. Four architectures are covered: differential-drive robot, Ackermann-based steering robot, Articulated-based steering robot, and mobile wheeled pendulum.

020WRNES1 Work Ready Now 2 Cr.

Topics covered include: Personal Development - Communication Skills - Job Seeking Skills - Work Behaviors.