

BACHELOR OF ENGINEERING IN ELECTRICAL ENGINEERING**Main Language of Instruction:**French ☒ English ☐ Arabic ☐

Campuses Where the Program Is Offered: Regular Preparatory: CST, CLN, CLS, CZB – Honors Preparatory and Bachelor of Engineering: CST

OBJECTIVES

The Bachelor of Engineering in Electrical Engineering enables students to:

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

PROGRAM LEARNING OUTCOMES (COMPETENCIES)

- Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- Apply engineering design to produce solutions that meet specific needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- Engage effectively with diverse audiences.
- Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- Lead and collaborate effectively within a team, fostering an inclusive environment, establishing goals, planning tasks, and achieving objectives.
- Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- Acquire and apply new knowledge as needed, using appropriate learning strategies.

PROGRAM REQUIREMENTS

In the Preparatory classes, students pursue either the Honors track or the Regular track. Once the two years of the Preparatory track are completed, they join the three-year Major Engineering classes.

Preparatory Classes – Honors Track

120 credits: Required courses (120 credits including 10 credits for USJ General Education Program)

Required Courses (120 Cr.)

Algebra 1 (6 Cr.). Algebra 2 (6 Cr.). Algebra 3 (4 Cr.). Analysis 1 (4 Cr.). Analysis 2 (6 Cr.). Analysis 3 (4 Cr.). Discrete Mathematics (6 Cr.). General Analysis (6 Cr.). Advanced General Chemistry (4 Cr.). Electromagnetism (4 Cr.). General Chemistry (4 Cr.). General Chemistry Laboratory (2 Cr.). Magnetic Induction (2 Cr.). Mechanics 1 (6 Cr.). Mechanics 2 (4 Cr.). Physical Signals (6 Cr.). Physics Laboratory 1 (2 Cr.). Physics Laboratory 2 (2 Cr.). Quantum Physics (2 Cr.). Signal Processing (2 Cr.). Thermodynamics 1 (6 Cr.). Thermodynamics 2 (2 Cr.). Wave Optics (2 Cr.). Programming 1 (4 Cr.). Programming 2 (4 Cr.). Programming 3 (2 Cr.). Digital Systems Design (4 Cr.). Linear Electrical Systems and Networks (4 Cr.). Supervised Personal Initiative Work (2 Cr.). Engineering at the Service of the Community (2 Cr.). French and Philosophy 1 (2 Cr.). French and Philosophy 2 (2 Cr.). USJ Values in Daily Life (2 Cr.).

Preparatory Classes – Regular Track

120 credits: Required courses (116 credits), Open elective courses (4 credits), USJ General Education Program (10 credits - may be part of the above categories)

Required Courses (116 Cr.)

Algebra 1 (4 Cr.). Algebra 2 (6 Cr.). BIM Modeling of Electrical Installations (4 Cr.). Calculus 1 (6 Cr.). Calculus 2 (6 Cr.). Calculus 3 (4 Cr.). Calculus 4 (6 Cr.). Discrete Mathematics (6 Cr.). Electric Circuits 1 (6 Cr.). Electric Circuits 2 (6 Cr.). Electromagnetism (4 Cr.). Engineering at the Service of the Community (2 Cr.). General Chemistry (4 Cr.). Introduction to Artificial Intelligence (4 Cr.). Introduction to Engineering Projects (4 Cr.). Introduction to Heat Transfer (2 Cr.). Logic Circuits (6 Cr.). Mechanics 1 (6 Cr.). Numerical Computing and Simulation (4 Cr.). Physics Laboratory 1 (2 Cr.). Physics Laboratory 2 (2 Cr.). Probability (4 Cr.). Programming 1 (6 Cr.). Programming 2 (6 Cr.). Thermodynamics 1 (4 Cr.). USJ Values in Daily Life (2 Cr.).

Open Elective Courses (4 Cr.)

Major Engineering Classes

180 credits: Required courses (154 credits), Institution's Elective Courses (22 credits), Open Elective Courses (4 credits) and USJ General Education Program (24 credits - may be part of the above categories).

Fundamental Courses (176 Cr.)

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.). 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.). Professional English (4 Cr.). Statistics (4 Cr.). Variable-Speed Drive Systems (6 Cr.). Corporate Internship (2 Cr.). Multidisciplinary Project (6 Cr.). Final Year Project (16 Cr.).

Institution's Elective Courses (22 Cr.), to be chosen from the list below:

Advanced Microcontroller Systems (4 Cr.). Artificial Intelligence (4 Cr.). Design of Mechatronic 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.). Pollution, Environment and Sustainability (4 Cr.). Power Generation (4 Cr.). Profitability of Energy Projects (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.)

USJ General Education Program (34 Cr.)

Code	Course Name	Credits
	ENGLISH OR OTHER LANGUAGE	4
020ENGES4	Professional English	4
	ARABIC	2
	<i>Arabic Language and Culture</i>	2
435LALML2	One Arabic Culture and Language course to be selected from:	2
435LALAL2	Arabic Language and Media	
435LRCTL2	Arabic Language and Arts	
	Arabic Language: Contemporary Novel, Cinema, and Theater	

	HUMANITIES	8
064VALEL1	USJ Values in Daily Life	2
	<i>Ethics</i>	4
020ETHES3	Business Ethics	4
	<i>Civic Engagement and Citizenship</i>	2
020GSCC1 or 020GSCN12	Engineering at the Service of the Community	2
	SOCIAL SCIENCES	6
	<i>Professional Integration and/or Entrepreneurship</i>	2
020ENTES1 020WRNES1	One Institution's Elective Course to be selected between: Entrepreneurship Work Ready Now	2
	<i>Other Social Sciences Course</i>	4
020GPRES2	Project Management	4
	QUANTITATIVE TECHNIQUES	6
020MADC1 or 020MADN1	Discrete Mathematics	6
	COMMUNICATION TECHNIQUES	8
020TCOES2	Communication Skills	2
020PRMES4	Multidisciplinary Project	2 out of 6
020PFES6	Final Year Project	4 out of 16

SUGGESTED STUDY PLAN

In the Preparatory classes, students pursue either the Honors track or the Regular track. Once the two years of the Preparatory track are completed, they join the three-year Major Engineering program.

Preparatory Classes

Semester 1

Code	Course Name	Credits
	Honors Track	
020MADC1	Discrete Mathematics	6
020GSCC1	Engineering at the Service of the Community	2
020ANGC1	General Analysis	6
020CHGC1	General Chemistry	4
020MC1C1	Mechanics 1	6
020SPHC1	Physical Signals	6
	Total	30
	Regular Track	
020AN1N1	Calculus 1	6
020MADN1	Discrete Mathematics	6
020CE1N1	Electric Circuits 1	6

020MC1NI1	Mechanics 1	6
020CSNNI1	Numerical Computing and Simulation	4
020TP1NI1	Physics Laboratory 1	2
	Total	30

Semester 2

Code	Course Name	Credits
	Honors Track	
020AL1CI2	Algebra 1	6
020AA1CI2	Analysis 1	4
020FR1CI2	French and Philosophy 1	2
020TCGCI2	General Chemistry Laboratory	2
020INMCI2	Magnetic Induction	2
020PP1CI2	Physics Laboratory 1	2
020IF1CI2	Programming 1	4
020TH1CI2	Thermodynamics 1	6
	Total	28
	Regular Track	
020AL1NI2	Algebra 1	4
020AN2NI2	Calculus 2	6
020GSCNI2	Engineering at the Service of the Community	2
020CLONI2	Logic Circuits	6
020IN1NI2	Programming 1	6
020TH1NI2	Thermodynamics 1	4
	Open Elective Course	2
	Total	30

Semester 3

Code	Course Name	Credits
	Honors Track	
020CHACI3	Advanced General Chemistry	4
020AL2CI3	Algebra 2	6
020AN2CI3	Analysis 2	6
020EMECI3	Electromagnetism	4
020FR2CI3	French and Philosophy 2	2
020MC2CI3	Mechanics 2	4
020PP2CI3	Physics Laboratory 2	2
020IF2CI3	Programming 2	4
020TRSCI3	Signal Processing	2
020OPTCI3	Wave Optics	2
	Total	36

	Regular Track	
020AL2NI3	Algebra 2	6
020AN3NI3	Calculus 3	4
020CE2NI3	Electric Circuits 2	6
020EMENI3	Electromagnetism	4
020CHGNI3	General Chemistry	4
020IN2NI3	Programming 2	6
	Total	30

Semester 4

Code	Course Name	Credits
	Honors Track	
020AL3CI4	Algebra 3	4
020AN3CI4	Analysis 3	4
020TEDCI4	Digital Systems Design	4
020SRLCI4	Linear Electrical Systems and Networks	4
020IF3CI4	Programming 3	2
020PHQCI4	Quantum Physics	2
020TIPCI4	Supervised Personal Initiative Work	2
020TH2CI4	Thermodynamics 2	2
064VALEL1	USJ Values in Daily Life	2
	Total	26
	Regular Track	
020MIENI4	BIM Modeling of Electrical Installations	4
020AN4NI4	Calculus 4	6
020IIANI4	Introduction to Artificial Intelligence	4
020PRINI4	Introduction to Engineering Projects	4
020ITCNI4	Introduction to Heat Transfer	2
020TP2NI4	Physics Laboratory 2	2
020PRBNI4	Probability	4
064VALEL1	USJ Values in Daily Life	2
	Open Elective Course	2
	Total	30

Major Engineering Classes

Semester 5

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
020WRNES1 or 020ENTES1	Institution's Elective course Work Ready Now or Entrepreneurship	2
	Total	32

Semester 6

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 Course	2
	Total	34

Semester 7

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 8

Code	Course Name	Credits
020CCAES4	DC-AC Conversion	4
020ENGES4	Professional English	4
020CTMES4	Modern Control	4
020PRMES4	Multidisciplinary Project	6
020EVVES4	Variable-Speed Drive Systems	6
	Institution's Elective Courses	8
	Open Elective Course	2
	Total	34

Semester 9

Code	Course Name	Credits
020CMPES5	Accounting	4
020ETHES3	Business Ethics	4
020DRAES5	Business Law	2
020STGES5	Corporate Internship	2
020MNGES5	Management	2
020ANRES4	Power Systems Analysis	4
020ERNES6	Renewable Energy	4
	Institution's Elective Courses	8
	Total	30

Semester 10

Code	Course Name	Credits
020PFES6	Final Year Project	16
	Total	16

COURSE DESCRIPTION

Preparatory Classes – Honors Track

020CHACI3 Advanced General Chemistry 4 Cr.

This course provides students with the basic principles of chemical thermodynamics as well as electrochemistry, including the laws of thermodynamics; enthalpy, entropy, internal energy, free energy, chemical potential, phase equilibria; the equilibrium constant; characterization of the intensive state of a system in equilibrium: variance of a system in equilibrium. optimization of a chemical process; overvoltage: current-potential curves; spontaneous transformations; batteries and electrolyzers; mixed potential, corrosion potential, corrosion current intensity, uniform corrosion in acidic or neutral oxygenated medium; differential corrosion by heterogeneity of the support or the environment; protection against corrosion.

Prerequisite: General Chemistry (020CHGCI1).

020AL1CI2 Algebra 1 6 Cr.

This course covers the following: Algebraic structures, vector spaces, linear applications, matrices, determinants, linear systems, Euclidean spaces.

020AL2CI3 Algebra 2 6 Cr.

This course explores the advanced study of algebraic structures such as groups, rings, and fields. It includes a detailed examination of endomorphisms, matrix reduction, and special substructures of algebraic structures like ideals. Topics explored include classification of matrices, the computation of eigenvalues and matrix equivalence. With a mix of theoretical understanding and practical applications, students will gain a comprehensive understanding of these mathematical concepts.

Prerequisite: Algebra 1 (020AL1CI2).

020AL3CI4 Algebra 3 4 Cr.

This advanced course is divided into two main parts. The first part focuses on inner product spaces, exploring concepts such as inner products, orthogonal vectors, orthonormal bases, and isometry in 2 and 3-dimensional Euclidean spaces. This section also delves into the study of symmetric endomorphisms and orthogonal matrices. The second part of the course introduces probability theory, including probability spaces, discrete random variables, probability distributions, and the law of large numbers. Building on the foundations of Algebra 2, this course provides students with a comprehensive understanding of these mathematical disciplines.

Prerequisites: Algebra 2 (020AL2CI3), Analysis 1 (020AA1CI2).

020AA1Cl2	Analysis 1	4 Cr.
------------------	-------------------	--------------

This course covers the following: Asymptotic analysis: Taylor series- Integration on a segment: integration and differentiation - Riemann sums - Real and complex series, series with positive terms, convergence and absolute convergence - Combinatorics: Cartesian product, arrangements, combinations, finite sets cardinality, probability on a finite space, Bayes' formula, independence, and finite random variables.

020AN2Cl3	Analysis 2	6 Cr.
------------------	-------------------	--------------

This course covers the following: Normed vector spaces: continuity, uniform continuity and Lipschitz continuity, compactness, linear maps, path connectedness – Generalized integrals: tests of convergence, dominated convergence - Functions of several variables: directional and partial derivatives, differentiability, gradient, extrema of functions of several variables, differential forms, multiple integrals, and line integrals.

Prerequisite: Analysis 1 (020AA1Cl2).

020AN3Cl4	Analysis 3	4 Cr.
------------------	-------------------	--------------

This course covers series and summable families, sequences and series of functions, integration and differentiation of a series of functions, power series, probability and discrete random variables, linear differential equations and systems of the form $X' = A(t)X + B(t)$, the method of constant variation, and Lagrange's method.

Prerequisite: Analysis 2 (020AN2Cl3)

020TEDCl4	Digital Systems Design	4 Cr.
------------------	-------------------------------	--------------

This course covers various methods of designing simple digital systems. Students will learn how to decompose a function into combinational and sequential blocks, and discover techniques for automating industrial processes based on specifications. The course content covers essential concepts such as number systems and codes, combinational and sequential logic, logical functions, and integrated logic circuits. Students will also explore topics including De Morgan's theorem, Karnaugh maps, flip-flops, synchronous and asynchronous binary counters/decoders, and shift registers. Practical work will be conducted to apply these concepts.

020MADCl1	Discrete Mathematics	6 Cr.
------------------	-----------------------------	--------------

This course covers the following: Logic and reasoning, Set theory, Applications, Binary relations, Algebraic calculations, Complex numbers, Integer arithmetic, and Polynomials.

020EMECI3	Electromagnetism	4 Cr.
------------------	-------------------------	--------------

This course starts with a separate study of the stationary case of the electric and the magnetic fields. Geometrical symmetries are used to benefit from the properties of the flux and the circulation of a vector field. Stationary local equations are introduced as a special case of Maxwell's equations. After a presentation of the Maxwell equations and the electromagnetic (EM) energy, attention is focused on the propagation of EM waves in vacuum, in conductors, in plasma and far away from an EM oscillating dipole.

Prerequisites: Physical Signals (020SPHC1), General Analysis (020ANGCl1).

020GSCCl1	Engineering at the Service of the Community	2 Cr.
------------------	--	--------------

This course introduces students to local societal and environmental issues and highlights the role of engineers as responsible and engaged members of society. Through a community-focused project, students will apply their technical and interpersonal skills to address a real-world issue.

020FR1Cl2	French and Philosophy 1	2 Cr.
------------------	--------------------------------	--------------

This course is offered to students in Mathématiques supérieures - section Concours to prepare them for the written French competitive examination for admission to polytechnic schools (*Filière Universitaire Internationale-Formation Francophone FUI-FF*). It equips students with the knowledge and skills needed to succeed in the examination.

020FR2CI3	French and Philosophy 2	2 Cr.
------------------	--------------------------------	--------------

This course is offered to students in Mathématiques spéciales - section Concours to prepare them for the written French competitive examination for admission to polytechnic schools (*Filière Universitaire Internationale-Formation Francophone FUI-FF*). It equips students with the knowledge and skills needed to succeed in the examination.

020ANGCI1	General Analysis	6 Cr.
------------------	-------------------------	--------------

This course covers a set of real numbers, real functions, trigonometric functions, logarithmic functions, power functions, inverse trigonometric functions, hyperbolic functions, linear first order differential equations, second order differential equations with constant coefficients, real and complex sequences, limits and continuity of real functions, differentiability, Rolle's Theorem, and applications.

020CHGCI1	General Chemistry	4 Cr.
------------------	--------------------------	--------------

This course allows students to master acid-base balances, the preponderant reaction method, and the calculation of pH in the final state of chemical equilibrium as well as pH-metric and conductometric titrations. In addition, notions about oxidants and reductants, the electrochemical cell, the type of electrodes, the calculation of the electromotive force and the capacity of the cell, the potential of the electrode through the Nernst equation as well as titration by oxidation-reduction reaction are covered. Students will also learn the concept of heterogeneous equilibrium in aqueous solution, the effect of the common ion and of complexation on solubility, complexation reactions and the influence of pH on solubility. Finally, this course allows analyzing potential-pH diagrams through examples along vertical and horizontal lines.

020TCGCI2	General Chemistry Laboratory	2 Cr.
------------------	-------------------------------------	--------------

This course focuses on the comprehension of hazards and risks, as well as the identification of relevant safety guidelines. It aims to enhance students' knowledge regarding laboratory procedures, techniques, and safety protocols. Additionally, the course aims to develop students' skills in qualitative chemical analysis and titration of various mineral solutions, including acids, alkaline solutions, and precipitation reactions. Furthermore, students will learn to verify theoretical information through the determination of concentrations using electrochemical analytical methods such as spectrophotometric analysis. This course also familiarizes students with the equipment used in each laboratory session and establishes a strong foundation for data interpretation.

Prerequisite: General Chemistry (020CHGCI1).

020SRLCI4	Linear Electrical Systems and Networks	4 Cr.
------------------	---	--------------

This course serves as an introduction to the fundamental principles of electrical engineering, focusing on the analysis of electric circuits. Students will delve into resistive network analysis, AC network analysis, transient analysis, and explore frequency response and system concepts. The use of Bode, Black, and Nyquist diagrams will be extensively covered to provide a comprehensive understanding of electrical circuits.

Prerequisite: Physical Signals (020SPHCI1).

020INMCI2	Magnetic Induction	2 Cr.
------------------	---------------------------	--------------

This course introduces students to the magnetic field beyond the descriptive approach studied in high school. It covers practical applications such as compasses, electric motors, alternators, transformers, speakers, induction plates, and radio-frequency identification. The course also presents the concept of magnetic flux and extends the concept of the magnetic dipole from current-carrying circuits to magnets.

020MC1CI1	Mechanics 1	6 Cr.
------------------	--------------------	--------------

This course enables students to master the principles and fundamental concepts of classical physics (inertia principle, fundamental principle of dynamics, principle of reciprocal actions, work-energy theorem). This course reinforces their understanding of these principles through a wide range of concrete applications or real-life situations with all their richness, particularly in the field of engineering.

020MC2C13	Mechanics 2	4 Cr.
------------------	--------------------	--------------

This course focuses on the study of specific topics within classical mechanics. It provides students with a deeper understanding of non-inertial reference frames, friction phenomena, and solid rotation around a fixed axis. In the realm of non-inertial reference frames, students will explore the principles and equations necessary to analyze and solve problems involving accelerated systems. They will learn to account for the effects of fictitious forces, such as centrifugal and Coriolis forces, which arise in non-inertial frames. The course also delves into the intricate nature of friction, examining its various types and the factors affecting its magnitude. Students will acquire the skills to analyze the behavior of objects subject to both static and kinetic friction. Lastly, the study of solid rotation around a fixed axis enables students to comprehend the kinematics and dynamics of rotating bodies, including concepts like angular velocity, angular acceleration, and moments of inertia. Overall, this course equips students with the fundamental knowledge and problem-solving abilities necessary to tackle complex mechanical systems involving non-inertial reference frames, frictional forces, and solid rotation.

Prerequisite: Mechanics 1 (020MC1C11)

020SPHC1	Physical Signals	6 Cr.
-----------------	-------------------------	--------------

The course is concerned with a wide range of concepts already introduced at high school: periodic signals, spectra, electrical energy, Ohm's law, Joule's law, lenses, wavelength, light spectrum, digital signals, travelling wave, diffraction, interference, Doppler effect, Newton's law, mechanical energy, harmonic oscillator. It provides a smooth transition toward a more quantitative physics than the one seen at high school.

020PP1C12	Physics Laboratory 1	2 Cr.
------------------	-----------------------------	--------------

This practical work course is designed to bridge the gap between theoretical knowledge and practical application in the field of electrical engineering and physics. Throughout the course, students will engage in hands-on activities to gain a deeper understanding of various concepts. The key topics covered include resonance in RLC circuits, system analysis, circuit measurements, mechanics and motion, LabVIEW software, fields and characteristics, oscilloscope applications, Single-Degree-of-Freedom Oscillator, focal measurement, and Optical Systems. Overall, this practical work course is designed to equip students with the necessary skills to apply theoretical knowledge in real-world scenarios, fostering a comprehensive understanding of electrical engineering and physics concepts.

020PP2C13	Physics Laboratory 2	2 Cr.
------------------	-----------------------------	--------------

This course enables students to consolidate their theoretical knowledge through practical applications across a range of topics, including electrical circuits, linear filters, Fourier analysis, frequency analysis, the Thomson tube, thermal conduction, the Stefan-Boltzmann law, the oscillator with two degrees of freedom, diffraction and interference, as well as polarization.

Prerequisite: Physics Laboratory 1 (020PP1C12).

020IF1C12	Programming 1	4 Cr.
------------------	----------------------	--------------

This course covers the hardware components of a computer and the basic concepts of high-level programming using Python. The topics addressed include the computer's hardware components, algorithms, programming languages, Python and the IDLE environment, variables, arithmetic expressions and operators, primitive data types, input and output of data, built-in composite data types, simple statements, control statements, logical expressions, relational and logical operators, function definition and call, functions from external modules.

020IF2C13	Programming 2	4 Cr.
------------------	----------------------	--------------

This course covers LIFO and FIFO structures. Topics include a systematic study of existing sorting algorithms and how to calculate their time complexity. It also covers the basic concepts of object-oriented programming and their application to data abstraction by introducing the concepts of object instantiation, attributes, and methods. It also introduces relational databases.

Prerequisite: Programming 1 (020IF1C12)

020IF3C14	Programming 3	2 Cr.
------------------	----------------------	--------------

This course covers the following: C Programming and algorithms with Categorical Abstract Machine Language (CAML) – variables, arithmetic expressions and operators, primitive data types, data input and output, built-in

composite data types, simple statements, control statements, logical expressions, relational and logical operators, function definition and call, functions from external modules – array – dynamic programming – recursive structures (lists, trees) – LIFO – FIFO – complexity – graph – propositional logic – deterministic and non-deterministic finite state automata – regular expressions.

Prerequisite: Programming 1 (020IF1C12).

020PHQC14	Quantum Physics	2 Cr.
------------------	------------------------	--------------

This course is concerned with two aspects of modern physics. The first is based on the Schrödinger formulation of wave mechanics and treats simple but fundamental problems: free particle, particle in a single-step potential, tunnel effect, particle in a box and energy quantization. The second is an introduction to statistical thermodynamics where macroscopic properties of a system are related to its microscopic constituents. The Boltzmann factor is introduced for the isothermal atmosphere model then generalized to systems with a discrete spectrum of energy. The equipartition theorem is then used to evaluate the heat capacity of gases and solids.

Prerequisite: Electromagnetism (020EMEC13).

020TRSC13	Signal Processing	2 Cr.
------------------	--------------------------	--------------

This course aims to provide students with a thorough understanding of key concepts related to filtering of periodic signals and sampling. Students will have the opportunity to deepen their knowledge of linear filters, understanding their operation and exploring the effects of first and second-order filters on a periodic signal. Special attention is given to the sampling process, with a detailed study of the Nyquist-Shannon theorem, which establishes the necessary conditions to avoid spectrum folding. Additionally, students will become familiar with digital filtering.

Prerequisite: Physical Signals (020SPHC1).

020TIPCI4	Supervised Personal Initiative Work	2 Cr.
------------------	--	--------------

This course enables students to undertake an individual project focused on the scientific and technological research process. They will formulate preliminary questions, conduct research, analyze real-world phenomena, and investigate a related issue using established scientific methods. The project emphasizes independent inquiry and discovery, enabling students to develop and apply their initiative and creativity through the construction of conceptual and practical outcomes.

020TH1C12	Thermodynamics 1	6 Cr.
------------------	-------------------------	--------------

This course focuses on the laws governing the macroscopic properties of a pure substance by covering fundamental concepts such as work, heat, and temperature. Students will understand, describe, and quantify the operation of thermodynamic machines such as engines, refrigerators, and heat pumps.

020TH2C14	Thermodynamics 2	2 Cr.
------------------	-------------------------	--------------

This course enables students to master and apply the concepts and fundamental principles of thermodynamics. It aims to develop the ability to solve practical problems using energy, mass, and entropy balances. Indeed, energy in all its forms is studied in various machines, such as internal combustion engines, turbojets for aerospace and naval propulsion, gas or steam turbines, thermal power plants, and refrigeration systems. Special attention is then given to heat transfer problems, which require a command of powerful tools (Laplacian, divergence) in concrete situations. Students will become familiar with partial differential equations and learn to manipulate the famous heat diffusion equation with or without a source term in Cartesian, cylindrical, or spherical geometry.

Prerequisite: Thermodynamics 1 (020TH1C12).

064VALEL1	USJ Values in Daily Life	2 Cr.
------------------	---------------------------------	--------------

This course introduces students to the core values of Saint Joseph University of Beirut (USJ), enabling them to integrate these values into their personal, interpersonal, and professional lives. It encourages students to critically reflect on how the values outlined in the USJ Charter can influence their behaviors, actions, and decisions in addressing the challenges of the contemporary world. It also raises awareness of global issues and ethical responsibilities, preparing students to contribute positively to society.

020OPTCl3	Wave Optics	2 Cr.
------------------	--------------------	--------------

This course covers the key concepts of the wave theory of light. It begins with the definition of spherical and plane waves, accompanied by a comprehensive exploration of key principles associated with them, such as optical path length, wave intensity, wavefront, wave trains, and coherence length. Special attention is given to light interference through wavefront division (Young's double-slit experiment) and through amplitude division (Michelson interferometer). The impact of extended and narrow-spectrum light sources is also examined. Furthermore, an analysis of the Fraunhofer diffraction phenomenon is presented, followed by a study of interference generated by multiple coherent waves and the use of a diffraction grating.

Prerequisite: Physical Signals (020SPHC1).

Preparatory Classes – Regular Track

020AL1NI2	Algebra 1	4 Cr.
------------------	------------------	--------------

This course introduces the fundamental concepts of finite-dimensional linear algebra. It begins with matrices and their operations, focusing on key properties such as invertibility and row-echelon forms. Students will study determinants, their fundamental properties, and their applications to matrix computations and the solution of linear systems. The course then covers vector spaces and subspaces, linear combinations, spanning sets, linear independence, and bases. It concludes with the concepts of dimension, rank, sums of subspaces, and hyperplanes.

020AL2NI3	Algebra 2	6 Cr.
------------------	------------------	--------------

This course introduces the fundamental concepts of linear algebra related to linear transformations, endomorphisms, and Euclidean spaces. Students will study the kernel, image, and rank of linear transformations, as well as their matrix representations and change of basis. The course then covers endomorphisms and their reduction, including eigenvalues, eigenvectors, characteristic polynomials, diagonalization, and triangularization. It concludes with Euclidean spaces and inner products, focusing on orthogonality, orthogonal projection, and distance.

Prerequisite: Algebra 1 (020AL1NI2)

020MIENI4	BIM Modeling of Electrical Installations	4 Cr.
------------------	---	--------------

This course introduces Electrical Engineering students to the concepts and methodologies of Building Information Modeling (BIM) applied to the digital representation and coordination of electrical building systems through the use of Autodesk Revit MEP. Students will learn to create digital representations of electrical installations, including lighting systems, power distribution networks, grounding systems, safety systems, and communication infrastructures, through practical exercises and case studies. The course is structured around an introduction to the Revit MEP environment (graphical interface, families, types, parameters, levels, views, and BIM coordination), followed by the digital representation of electrical equipment and networks, the integration of associated technical information, clash detection, and multidisciplinary coordination with other building systems. The course also covers quantity takeoff generation (BOQ), automated production of electrical drawings and schematics, and the principles of digital collaboration within a BIM project. Through an applied project, students will develop a complete BIM model of a building's electrical systems in accordance with current construction industry practices.

020AN1NI1	Calculus 1	6 Cr.
------------------	-------------------	--------------

This course provides an in-depth introduction to the fundamental concepts of mathematical analysis, including transcendental functions, continuity, analytical differentiation and numerical differentiation. It then broadens the study of transcendental functions by introducing inverse trigonometric functions and hyperbolic functions. Students will examine the behavior of numerical sequences through several fundamental concepts, including convergence and various types of sequences. In the final part, the course presents Taylor series expansions of functions and emphasizes their importance in local approximation and in the study of the behavior of functions near a point.

020AN2NI2	Calculus 2	6 Cr.
-----------	------------	-------

Through a progressive approach that combines theory, practice and critical thinking, this course aims to strengthen students' foundations in mathematical analysis. It covers the main techniques of integral calculus, including integration by parts, change of variables and the integration of rational and trigonometric functions. The course then examines improper integrals, with particular emphasis on convergence and on the criteria applicable to positive functions and sign-changing functions. It continues with the study of numerical series, including positive-term series and alternating series, together with a rigorous analysis of the convergence of power series. Finally, the course introduces Fourier series by presenting the conditions for their existence, real and complex Fourier coefficients, Dirichlet's convergence criteria and methods for determining the sums of convergent series.

Prerequisite: Calculus 1 (020AN1NI1)

020AN3NI3	Calculus 3	4 Cr.
-----------	------------	-------

This course enables students to acquire rigorous methods for solving differential equations. It focuses on first-order differential equations, including separable, linear, exact and homogeneous equations, as well as higher-order differential equations. The methods of order reduction, undetermined coefficients, and variation of parameters, as well as Cauchy–Euler equations, are also presented. The course then introduces power series solutions in the neighborhood of ordinary and singular points. It concludes with the study of the Laplace transform and its applications to solving differential equations and linear systems.

Prerequisite: Calculus 2 (020AN2NI2)

020AN4NI4	Calculus 4	6 Cr.
-----------	------------	-------

This course introduces advanced concepts in mathematical analysis, beginning with the study of functions of several variables. It explores the concepts of extrema and implicit functions, as well as techniques for evaluating double and triple integrals using various coordinate systems, such as Cartesian, polar, and cylindrical coordinates. Line integrals also constitute an important part of the course. They are essential for computing the circulation of a vector field along a given path. The final part of the course is devoted to complex analysis, focusing on complex functions, their fundamental properties, the residue theorem, and their role in various areas of applied mathematics and engineering sciences.

Prerequisite: Calculus 2 (020AN2NI2)

020MADNI1	Discrete Mathematics	6 Cr.
-----------	----------------------	-------

This course introduces the essential mathematical foundations for first-year preparatory class students. It establishes the basis for rigorous reasoning and mathematical structures used across mathematics, physics, and computer science. The course begins with propositional logic and proof techniques, enabling students to read and construct correct mathematical arguments. It then covers numbers — integers, rationals, reals, and complex numbers. The chapter on natural numbers and induction introduces a fundamental proof tool, widely used throughout the curriculum. The second part of the course focuses on structures: sets, binary relations, and functions, which form the core language of modern mathematics. Emphasis is placed on the notational and reasoning rigor expected at university level.

020CE1NI1	Electric Circuits 1	6 Cr.
-----------	---------------------	-------

This course covers first- and second-order linear circuits, and linear filters. Students will explore harmonic oscillators, the general laws of electrokinetics, complex representations of signals, impedances and admittances, and the different types of linear filters. They will acquire the knowledge and skills needed to analyze, model, and solve problems related to these topics.

020CE2NI3	Electric Circuits 2	6 Cr.
-----------	---------------------	-------

This course introduces the fundamental principles of electrical engineering, with a particular emphasis on electric circuit analysis. Students will develop a thorough understanding of resistive network analysis, alternating current (AC) circuit analysis, and transient response analysis, while exploring frequency response and system concepts. The use of Bode, Black, and Nyquist diagrams is extensively covered to provide a comprehensive understanding of the behavior, analysis, and design of electrical circuits and dynamic systems.

Prerequisite: Electric Circuits 1 (020CE1NI1)

020EMENI3	Electromagnetism	4 Cr.
-----------	------------------	-------

This course begins with a distinct examination of the stationary electric and magnetic fields. Geometrical symmetries are used to benefit from the properties of the flux and circulation of a vector field. Stationary local equations are introduced as a special case of Maxwell's equations. Following the presentation of Maxwell's equations and the electromagnetic (EM) energy, attention is shifted to the propagation of EM waves in vacuum.
Prerequisite: Calculus 2 (020AN2NI2)

020GSCNI2	Engineering at the Service of the Community	2 Cr.
-----------	---	-------

This course introduces students to local societal and environmental issues and highlights the role of engineers as responsible and engaged members of society. Through a community-focused project, students will apply their technical and interpersonal skills to address a real-world issue.

020CHGNI3	General Chemistry	4 Cr.
-----------	-------------------	-------

This course introduces students to the fundamental principles of chemistry and their application in the laboratory. On the theoretical side, it covers acid-base equilibria, redox reactions, electrochemical cells, and heterogeneous equilibria in aqueous solutions, with particular emphasis on pH calculations and the analysis of potential-pH diagrams. Laboratory sessions focus on laboratory safety, experimental procedures, and the proper handling of equipment. Students will develop practical skills in titration techniques, qualitative analysis, and electrochemical and spectrophotometric methods, enabling them to connect theoretical concepts with experimental results and to acquire a solid level of scientific autonomy.

020IIANI4	Introduction to Artificial Intelligence	4 Cr.
-----------	---	-------

This course introduces the fundamental concepts of artificial intelligence and machine learning. Students will discover the key stages of a machine learning project, from data preparation and exploration to model training and evaluation. The course covers the main approaches to machine learning, including supervised learning (classification and regression), unsupervised learning (clustering), and the fundamental principles of reinforcement learning. Emphasis is placed on data quality, result interpretation, and model performance evaluation. Through case studies and hands-on exercises, students will develop the skills required to build simple AI solutions and gain an understanding of the limitations, challenges, and broader implications of applying these technologies in modern digital systems.

020PRINI4	Introduction to Engineering Projects	4 Cr.
-----------	--------------------------------------	-------

This course introduces students to the scientific research process and develops their ability to approach research with the responsibility expected of researchers and engineers. It integrates scientific and technological research through the development of conceptual and tangible components that contribute to the process of knowledge creation, from ideation and design to, where applicable, realization.

020ITCNI4	Introduction to Heat Transfer	2 Cr.
-----------	-------------------------------	-------

This course explores the fundamental principles of heat transfer mechanisms such as conduction, convection, and radiation, with an emphasis on thermal conduction. The objective is to establish the thermal balance and apply Fourier's laws to determine the heat equation. Additionally, students will be able to calculate the thermal resistance of different systems, which is crucial for the design of efficient heat transfer systems. This introductory course on heat transfer provides the necessary foundations to understand and analyze heat transfer phenomena in a variety of systems. This is essential in many fields such as thermal engineering, materials science, thermodynamics, and more.

Prerequisite: Thermodynamics 1 (020TH1NI2).

020CLONI2	Logic Circuits	6 Cr.
-----------	----------------	-------

This course provides students with the opportunity to become familiar with the various methods used in the design of simple digital systems. Students will learn how to decompose a function into combinational and sequential logic blocks and discover techniques for automating industrial processes based on a given set of specifications. The course covers the fundamental concepts of number systems and coding schemes, combinational and sequential logic, logic functions, and integrated logic circuits. Students also explore topics such as De Morgan's theorem,



Karnaugh maps, flip-flops, synchronous and asynchronous binary counters, and shift registers. Laboratory sessions are included to provide hands-on experience and reinforce the theoretical concepts through practical implementation.

020MC1NI1	Mechanics 1	6 Cr.
------------------	--------------------	--------------

This course aims to provide students with the fundamentals of classical mechanics applied to a particle. The concepts of kinematics and dynamics are studied to model and analyze the motion of mechanical systems. The principles of work and energy are developed to investigate energy transformations and their applications in mechanical systems. The course also introduces the concept of angular momentum and the associated conservation laws, providing students with a solid foundation for further studies in engineering mechanics.

020CSNNI1	Numerical Computing and Simulation	4 Cr.
------------------	---	--------------

This course covers various key aspects of MATLAB and Simulink, with a particular focus on symbolic computation in calculus and algebra, matrix calculations, programming, and an introduction to Simulink. Students will explore the advanced features of MATLAB in depth, with an emphasis on its application in different engineering fields. Symbolic calculus and algebra enable students to manipulate complex mathematical expressions, simplify equations, compute derivatives and integrals, and solve systems of symbolic equations. Students will learn to manipulate matrices and vectors and perform essential matrix operations. Additionally, the course covers practical aspects of MATLAB programming, teaching students how to write custom scripts and functions. The course also introduces Simulink, MATLAB's graphical environment dedicated to modeling and simulating dynamic systems. In summary, this course provides students with a comprehensive understanding of MATLAB and Simulink, emphasizing their application in engineering. Topics include symbolic algebra, matrix calculations, essential programming skills in MATLAB, and an introduction to Simulink for modeling and simulating dynamic systems.

Prerequisites: General Analysis (020ANGNI1), Programming 1 (020IF1NI2).

020TP1NI1	Physics Laboratory 1	2 Cr.
------------------	-----------------------------	--------------

This practical work course is designed to bridge the gap between theoretical knowledge and practical application in electrical engineering and physics. Throughout the course, students will engage in hands-on activities to gain a deeper understanding of various concepts. The key topics covered include resonance in RLC circuits, system analysis, circuit measurements, mechanics and motion, LabVIEW software, fields and characteristics, oscilloscope applications, single-degree-of-freedom oscillator, focal measurement, and optical systems. Overall, this practical work course is designed to equip students with the necessary skills to apply theoretical knowledge in real-world scenarios, fostering a comprehensive understanding of electrical engineering and physics concepts.

020TP2NI4	Physics Laboratory 2	2 Cr.
------------------	-----------------------------	--------------

This course allows students to reinforce their theoretical knowledge through practical applications across a variety of topics. They will explore areas such as electrical circuits, linear filters, Fourier analysis, frequency analysis, the Thomson tube, thermal conduction, the Stefan-Boltzmann law, the oscillator with two degrees of freedom, diffraction and interference, as well as polarization.

Prerequisite: Physics Laboratory 1 (020TP1NI1).

020PRBNi4	Probability	4 Cr.
------------------	--------------------	--------------

This course presents the fundamental concepts of probability theory and the tools used to model and analyze random phenomena. It begins with probability spaces and events. The main rules of probability are introduced through the notions of conditional probability, independence, the law of total probability, and Bayes' theorem. Counting techniques, including arrangements, permutations, and combinations, are also studied. The course then covers discrete and continuous random variables, their probability distributions, cumulative distribution functions, as well as the notions of expectation and variance. It includes the binomial, geometric, hypergeometric, Poisson, continuous uniform, exponential, and normal distributions. Finally, joint distributions of two random variables are also studied.

Prerequisite: Calculus 2 (020AN2NI2).



020IN1NI2	Programming 1	6 Cr.
------------------	----------------------	--------------

This course introduces the foundations of algorithms and programming using Python. Students will learn how to analyze problems, design effective algorithmic solutions, and implement them as clear, well-structured, and properly documented programs. The course covers core programming concepts, including variables, data types, conditional and iterative control structures, as well as the manipulation of lists, strings, and files. Emphasis is placed on modular program design through the use of functions, the decomposition of complex problems into manageable subproblems, and basic testing and validation techniques. The course also introduces students to the principles of algorithm specification and correctness, fostering a rigorous approach to software development. Finally, it explores the fundamentals of recursion and its relationship to inductive reasoning.

020IN2NI3	Programming 2	6 Cr.
------------------	----------------------	--------------

This course builds on the fundamental concepts of algorithms by introducing complexity analysis and key data structures. Students learn how to evaluate the computational cost of algorithms, compare different solutions to the same problem, and use asymptotic notation to characterize their efficiency. The course also covers recursion, abstract data structures such as stacks, queues, dictionaries, and sets, as well as the core principles of object-oriented programming. Emphasis is placed on the relationship between the choice of data structures, their implementation, and algorithm performance. Through the study of classical searching and sorting algorithms, students will develop the ability to analyze the correctness and complexity of proposed solutions and to select the most appropriate data structures and methods for a given problem.

Prerequisite: Programming 1 (020IN1NI2).

020TH1NI2	Thermodynamics 1	4 Cr.
------------------	-------------------------	--------------

This course enables students to master the key concepts of thermodynamics. It begins with an introduction to the different states of matter and scales of study. It then explores the state of a thermodynamic system, equations of state, and internal energy. Transformations of a thermodynamic system and the first law of thermodynamics are also studied, with a focus on pressure forces and heat transfers. The second law of thermodynamics and the concept of entropy are introduced, along with their applications. The course also covers the thermodynamic study of phase transitions.

064VALEL1	USJ Values in Daily Life	2 Cr.
------------------	---------------------------------	--------------

This course introduces students to the core values of Saint Joseph University of Beirut (USJ), enabling them to integrate these values into their personal, interpersonal, and professional lives. It encourages students to critically reflect on how the values outlined in the USJ Charter can influence their behaviors, actions, and decisions in addressing the challenges of the contemporary world. It also raises awareness of global issues and ethical responsibilities, preparing students to contribute positively to society.

020CMPES5	Major Engineering Classes Accounting	4 Cr.
------------------	---	--------------

This course covers the following: 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.
------------------	---	--------------

This course covers the following: 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 (020SMPE3)

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: Electric Circuits 2 (020CE2N13) or Linear Electrical Systems and Networks (020SRLC14)

435LALAL2	Arabic Language and Arts	2 Cr.
------------------	---------------------------------	--------------

This course introduces Modern Standard Arabic (MSA) through an interactive approach combining language learning, cultural awareness, and the development of critical thinking. In this track, the arts serve as a gateway to the Arabic language and to a deeper understanding of

Arabic cultures. Drawing on a variety of authentic materials, including painting, photography, music, poetry, calligraphy, architecture, and urban art, students will explore different forms of artistic expression and the cultural contexts in which they emerge. The course aims to develop students' skills in comprehension and expression in MSA. It also encourages the analysis of artistic works and reflection on the relationship between art, culture, and society.

435LALML2	Arabic Language and Media	2 Cr.
------------------	----------------------------------	--------------

This course introduces Modern Standard Arabic (MSA) through an interactive approach combining language learning, cultural awareness, and the development of critical thinking. In this track, media serve as a gateway to the Arabic language and to a deeper understanding of the contemporary Arabic world. Drawing on a variety of authentic materials, including newspapers, audiovisual and social media, and digital content, students will explore major issues and debates shaping contemporary Arabic societies. The course aims to develop students' skills in comprehension and expression in MSA. It also encourages critical engagement with media discourse and reflection on the role of media in contemporary societies.

435LRCTL2	Arabic Language: Contemporary Novel, Cinema, and Theater	2 Cr.
------------------	---	--------------

This course introduces Modern Standard Arabic (MSA) through an interactive approach combining language learning, cultural awareness, and the development of critical thinking. In this track, contemporary novels, theatre, and cinema serve as a gateway to the Arabic language

and to a deeper understanding of Arabic cultures. Drawing on a variety of authentic materials, including literary excerpts, theatrical texts, and film extracts, students will explore stories, characters, and themes that reflect the diversity of contemporary Arabic societies. The course aims to develop students' skills in comprehension and expression in MSA. It also encourages the analysis of literary and cinematic works and reflection on the relationship between culture, identity, and society.

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 of the need for 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 them.

020DRAES5	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.
------------------	-----------------------------	--------------

This course highlights the importance of communication for engineering students. It explains that, in academic and professional activities, transmitting information is a powerful tool for convincing and influencing others. This course emphasizes that communication is unavoidable and involves errors and risks that may disturb or distort the reception of information. It provides students with the essential basic rules of written, verbal, and non-verbal communication and raises awareness of 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.
------------------	-------------------------	--------------

This course covers different topologies of DC-AC switch-mode power converters: 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 conducted for each topology. Rating criteria based on the evaluation of the voltage and current stresses are established.

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.
------------------	-------------------------	--------------

This course covers different topologies of DC-DC switch-mode power converters. 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 conducted for each topology. Rating criteria based on the evaluation of the voltage and current stresses are established.

Prerequisite: Industrial Electronics (020ELIES2)

020CSMES4	Design of Mechatronic Systems	4 Cr.
------------------	--------------------------------------	--------------

This course provides a comprehensive introduction to mechatronics and microcontroller systems, with a strong focus on the integration of mechanical components, electronics, and data-driven control. Students will learn to combine mechanical design with microcontrollers, sensors, and control systems to design and implement functional mechatronic solutions across a range of applications. In addition, students will collaborate on a team-based project that applies these concepts to real-world scenarios, fostering both technical and teamwork skills.

Prerequisite: Sensors and Instrumentation (020CEIES3).

020ELNES2	Digital Electronics	6 Cr.
------------------	----------------------------	--------------

This course includes the following: Introduction to digital integrated circuit technology. Digital integrated circuits using MOS transistors, CMOS characteristics, fundamental building blocks, transistor level design of CMOS logic gate 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 system 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 simulation of a system in closed loop.

Prerequisites: Linear Control (020AULES2), Signals and Systems (020SYSES2)

020MSDES1	Dynamic Systems Modeling	4 Cr.
------------------	---------------------------------	--------------

This course explains the crucial importance of modeling and analysis in the industry nowadays that lead 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 introduces engineering design to students through iterative improvements, a feasibility study and process optimization before the usual industrial prototyping.

Prerequisite: Numerical Computing and Simulation (020CSNN1)

020ME1ES2	Electric Machines 1	6 Cr.
------------------	----------------------------	--------------

This course covers the following: 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.
------------------	--------------------------	--------------

This course covers the following: Earthing System, low voltage electrical equipment, Overview of IEC 60364 and NF C-15 100 standards, 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, glow-wire test, the bathrooms, Standards for electrical appliances in the bathroom, establishing an equipotential link. 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.
------------------	--------------------------	--------------

This course covers the following: 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 panels, 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, performing calculations, and producing 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, different types of lightning rods, differences between lightning rod and surge arrester, rules to follow and isolating spark gaps. **Prerequisite:** Electrification 1 (020IE1ES2).

020ETCES1	Electrotechnics	6 Cr.
------------------	------------------------	--------------

This course enables students to study 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, and 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 determine the values of the voltages, currents, powers, and efficiency at no-load, short-circuit and load operations.

Prerequisites: Electromagnetism (020EMENI3 or 020EMECI3), Electric Circuits 2 (020CE2NI3) or Linear Electrical Systems and Networks (020SRLCI4)

020SEMES3	Embedded Systems	4 Cr.
------------------	-------------------------	--------------

This course covers the following: 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 – FPGA: 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 hardware and software – NIOS II processor creation and programming.

Prerequisites: Logic Circuits (020CLONI2) or Digital Systems Design (020TEDCI4), Programming 1 (020IN1NI2 or 020IF1CI2)

020ENTES1	Entrepreneurship	2 Cr.
------------------	-------------------------	--------------

This course covers the following: 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.

020PFEEES6	Final Year Project	16 Cr.
-------------------	---------------------------	---------------

The final year project is a culminating engineering design experience undertaken by groups of 2 to 4 students under the supervision of a faculty member. Students will define the project, establish its objectives, conduct a state-of-the-art review of the project topic, develop the project specifications, and select an appropriate design methodology. They will apply the knowledge and skills acquired throughout their studies to develop a final product that progresses through all stages of design, modeling, analysis, testing, and evaluation. The main deliverables are a final report and two oral presentations.

Prerequisite: Validate 150 credits, Multidisciplinary Project (020PRMES4).

020MEFES2	Fluid Mechanics	4 Cr.
------------------	------------------------	--------------

This course covers the following: 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's and Bernoulli's theorems - Navier-Stokes equations. Dimensional analysis applying the PI theorem.

020LFLES5	Fuzzy Logic and Neural Networks	4 Cr.
------------------	--	--------------

This course covers two intelligent techniques for data processing drawn from complex and imprecise environments. Fuzzy Logic theory is based on the empirical aspect of 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.
------------------	------------------------	--------------

This course includes the following: Introduction to Home Automation. Communication modes: Dry contact, Serial, Infrared, and TCP-IP. Protocols: Wired and Wireless, Dedicated and Universal. Types of control: Lighting, electrical curtains, HVAC and audio-video equipment. Interfaces with other systems: Building management systems (BMS), Fire Alarm, Intrusion, CCTV and intercom. Internet of Things (IOT). User interfaces: Binary input, Wired Keypads, Wireless remote control, Touch screen and Mobile / Tablet applications. Concept of electrical installation for home automation, including the corresponding electrical panel. Load schedule with the number of circuits and type of control. Home Automation devices. KNX Protocol. ETS software. Concept of a typical project (requirement and recommendations).

020CL1ES3	HVAC 1	4 Cr.
------------------	---------------	--------------

This course covers the following: thermal comfort: thermal and hydrothermal exchange - interior basic conditions – exterior basic conditions - comfort elements: activity, clothes, hygrometry, radiation, temperatures - psychrometric chart: calculation and dimensioning of heating, cooling, humidifying, and dehumidifying systems for the interior environment - load estimation for heating, taking into account the impacts of ventilation, wall insulation, glazing treatment, lighting and heat-producing equipment - 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, and chimneys - heating with hot air: production of hot air, air handling unit, fan coil unit - presentation, design, and sizing using the psychrometric chart of heating coils, humidifiers, air filters, fans, and mixing box.

Prerequisites: Fluid Mechanics (020MEFES1 or 020MEFES2), Thermodynamics 2 (020TH2CI4) or Introduction to Heat Transfer (020ITCNI4 or 020THENI3).

020CL2ES4	HVAC 2	4 Cr.
------------------	---------------	--------------

This course covers the following: Heat pump – Mollier diagram – Environmental issues related to cooling fluids (Ozone and global warming) and new fluids – Summer thermal balance – 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 structured 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	4 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 systems on the flow of work, the optimal, experimental design, and optimizing processes.

020PRNES4	Industrial Process and Control	4 Cr.
------------------	---------------------------------------	--------------

This course covers the following: 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 types (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 – Organization Block (OB) – Function (FC) – Function Block (FB) – Data Block (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.
------------------	-------------------------	--------------

This course introduces machine learning (ML), a subfield of artificial intelligence focused on enabling machines to learn from examples. It explains that the goal of ML is to create computers that can learn autonomously, and covers main research topics, including computer vision, natural language processing, and precision medicine for personalized treatments. This course provides students with a basic understanding of ML algorithms and hands-on ML engineering experience using realistic datasets through Python implementations with 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.

020SMPE3	Microprocessor Systems	4 Cr.
-----------------	-------------------------------	--------------

This course covers the following: Differences between microprocessors, microcontrollers, and DSP – microprocessor architecture; implementation of a basic board – Microcontroller architecture (PIC 18F2520) – Implementation of ROM, RAM, and 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: Logic Circuits (020CLON12) **or** Digital Systems Design (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.
------------------	-----------------------	--------------

This course covers the following: Modeling a multivariable system, interpretation, and linearization. Response and transfer matrix. Realization in terms of controllability, observability, and Jordan forms. Controllability, and its properties, partial controllability. Observability and its criteria. Minimum realization, 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 involves students from different programs and/or concentrations who collaborate on an interdisciplinary engineering design project, with each student contributing expertise from their respective field. Students will apply the knowledge and skills acquired throughout their studies to address a design problem and develop a final product through the stages of design, modeling, analysis, testing, and evaluation. The project strengthens students' analytical, communication, and teamwork skills while developing their ability to apply their technical expertise in an interdisciplinary context. The main deliverables are a final report and an oral presentation.

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 the phase plane in the time domain. The stability theory of nonlinear systems is 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 characterized by its precision. The advantages and drawbacks of these two control methods with respect to conventional techniques are underlined. Their application in the control design of nonlinear industrial processes is also illustrated.

020MENES1	Numerical Methods	4 Cr.
------------------	--------------------------	--------------

This course covers the following: 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 systems of equations.

Prerequisites: Algebra 2 (020AL2NI3) **or** Algebra 1 (020AL1CI2), Calculus 3 (020AN3NI3) **or** Analysis 2 (020AN2CI3).

020CPPEs1	Object-Oriented Programming	6 Cr.
------------------	------------------------------------	--------------

This course covers the following: 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. Compilation with CMake. Code versioning with Git and GitHub.

Prerequisite: Programming 1 (020IN1NI2) **or** Programming 2 (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. Students will also 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 minima.

020PCBES5	PCB Design Fundamentals	4 Cr.
------------------	--------------------------------	--------------

This course introduces the fundamentals of designing printed circuit boards (PCBs) using an 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, parasitics, coupling, controlled impedance and power distribution. Additionally, this course includes a project realization of a complex circuit using Proteus software.

Prerequisite: Digital Electronics (020ELNES2)

020PEDES5	Pollution, Environment and Sustainability	4 Cr.
------------------	--	--------------

This course provides an overview of the causes and effects of global climate change, covering the basic science, projected impacts, and approaches to mitigation. It also includes methods for quantifying greenhouse gas emissions, controlling these emissions, and adapting to them, particularly in the HVAC/heating systems and building materials sectors. The course introduces the natural and anthropogenic carbon cycles, as well as carbon and climate concepts. Topics also cover the basics of green buildings, green materials for construction, material selection for sustainable design, green building certification, and methods for increasing energy efficiency in buildings. Additionally, the course includes the quantification of air, water, and soil pollution and their sources, sustainable wastewater treatment, solid waste management (sources and impacts), the zero-waste concept, and the 3R concept.

020PENES4	Power Generation	4 Cr.
------------------	-------------------------	--------------

This course covers the various technologies and methodologies used to generate electrical power. It encompasses theoretical principles, practical applications, and the environmental considerations associated with power generation, especially 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** 020MEFES2).

020ANRES4	Power Systems Analysis	4 Cr.
------------------	-------------------------------	--------------

This course introduces 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 a model, a performance study is conducted in both steady-state and transient conditions (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 a short-circuit disturbance is discussed. In addition, methods for the selection of isolators and protection devices are presented. Finally, the benefits of DC transmission systems and their technical aspects are presented.

020RPEES5	Profitability of Energy Projects	4 Cr.
------------------	---	--------------

This course enables students to understand, using economic tools, the profitability of an energy project. Topics covered include: Energy Efficiency Measures, Green Energy versus Gray Energy (Useful, Final, Secondary and Primary). Identification of the energy project and the financial package; Notions of Investment and technical and economic lifetimes; Annual Revenues and Earnings; Calculation of the simple Payback Period and return on investment; The energy Payback Period; Simple cumulative profit in cash flow; Subsidy and financial incentives; Inflation; Cost of Energy Improvement; Cost of kWh in cash flow; Concept of discount and calculation of the discount rate; Present value and future value; Discounted Payback Period; Net Present Value (NPV); Internal Rate of Return (IRR); Annual Gains in Constant Annuity (AGCA); Economized Fuel Cost (EFC); Cost of kWh in cash flow and discounted (LCE); Integration of externalities into energy costs; Case studies.

020GPRES2	Project Management	4 Cr.
------------------	---------------------------	--------------

This course explains how effective project management ensures that a project is completed on time, within budget, and with high quality. Specific techniques for accomplishing these three goals are not always so obvious. The purpose of this course is to teach students these successful techniques, and expose them to a variety of skills to manage the budget, schedule, and quality of projects that they are or will be responsible for.

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 of the potential and unique characteristics of renewable energies, particularly for 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 course, students will explore specific topics, including the principles of solar radiation, PV system components, design, selection and sizing. The course also explores the origin and power of wind, wind energy system components, turbine design and control, electrical aspects of wind turbines, and the essentials of wind energy system selection and sizing, along with an overview of the control structures and grid connection techniques. The course also introduces battery storage system technologies, their structure, principles of operation, performance and efficiency, battery charge/discharge cycles, battery management systems (BMS), battery models, equalization techniques, along with an introduction to fuel cells.

This comprehensive examination equips students with the knowledge and skills needed to navigate the complex landscape of renewable energy.

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 with sensors, actuators, and closed-loop representation, then covering dynamics and kinematics equations, and finally addressing the control of robots using linear, nonlinear, and adaptive controllers. Concepts of dynamic response related to vibration and motion planning are presented. The principles of operation of various actuators are discussed including pneumatic, magnetic, piezoelectric, linear, stepper, etc. Advanced feedback mechanisms are implemented using software executing in an embedded system. The concepts for real-time processor programming, image processing and artificial intelligence are also presented in this course. Neural networks and advanced controllers are shown along with their implementation using microcontrollers and/or software (MATLAB, LabVIEW, etc.).

020CEIES3	Sensors and Instrumentation	4 Cr.
------------------	------------------------------------	--------------

This course includes 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 Transform (FFT), recursive and non-recursive digital filters, synthesis of recursive and non-recursive filters.

Prerequisite: Calculus 4 (020AN4NI4) **or** Analysis 2 (020AN2CI3)

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

This course covers the following: Micro/nano satellite missions, orbits design and analysis, subsystem scheme, micro/nano satellite configuration design, system performance determination and analysis, reliability and safety analysis, technical processes for 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, STK tracker software, designing and implementing a (tabletop) nanosatellite of type Cubesat 1U using commercial components and boards.

Prerequisites: Analog Electronics (020ELAES1) **or** Electronics (020ELCES1)

020ENGES4	Professional English	4 Cr.
------------------	-----------------------------	--------------

This course develops students' critical thinking, reading, oral, and writing skills. It focuses on the critical analysis and synthesis of information from multiple sources, the preparation of a research paper, and the oral presentation and defense of their work. Students will develop their ability to analyze a range of text types relevant to their disciplines, synthesize information from diverse sources, and communicate their ideas effectively in writing and orally.

020STAES1	Statistics	4 Cr.
------------------	-------------------	--------------

This course provides a rigorous foundation in statistical inference, equipping students with the tools to make sound decisions based on data. It begins with a review of random variables and probability distributions, before distinguishing between descriptive and inferential statistics. Students will explore key concepts of sampling distributions and learn how to construct and interpret confidence intervals for means, variances, and proportions. The course then delves into parameter estimation techniques, including the method of moments and maximum likelihood estimation. In the latter half, emphasis is placed on the theory and application of statistical hypothesis testing for different types of parameters and distributions. Students will analyze real-world problems involving tests for means, variances, proportions, independence, and goodness-of-fit. The course concludes with an introduction to linear regression and non-parametric statistical tests.

Prerequisite: Probability (020PRBN14) **or** Algebra 3 (020AL3CI4).

020IPRES5	System Identification	4 Cr.
------------------	------------------------------	--------------

This course includes the following: Course introduction. System models: types 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-random binary signals: properties and design for identification purposes. Parametric models identification: least squares technique, recursive methods, weighted methods, 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 Drive Systems	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 kinematic 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 steering robot, and mobile wheeled pendulum.

020WRNES1	Work Ready Now	2 Cr.
------------------	-----------------------	--------------

This course covers the following topics: Personal Development - Communication Skills - Job Seeking Skills - Work Behaviors.

