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

Objectives – Honors Preparatory Electrical Engineering
The Electrical Engineering program 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.

Objectives – Regular Preparatory Electrical Engineering
The Electrical Engineering program 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.

Objectives – Bachelor of Engineering in Electrical Engineering
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)

Competencies – Honors Preparatory Electrical Engineering
- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- An ability to 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.
- An ability to effectively communicate with a range of audiences.
- An ability to 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.
- An ability to effectively function on a team whose members provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

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PROGRAM REQUIREMENTS

Students are required to choose either the Honors Preparatory track or the Regular Preparatory track. Once the two years of the chosen track are completed, they join the three-year Bachelor of Engineering program.

Honors Preparatory Electrical Engineering
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.).

Regular Preparatory Electrical Engineering
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.)
Analysis 1 (4 Cr.). Analysis 2 (6 Cr.). Bilinear Algebra and Geometry (6 Cr.). Differential Calculus (6 Cr.). Discrete Mathematics (6 Cr.). General Analysis (6 Cr.). Linear Algebra (8 Cr.). Probability (4 Cr.). Supplemental Mathematics (2 Cr.). Electromagnetism (4 Cr.). General Chemistry (4 Cr.). Introduction to Heat Transfer (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.). Thermodynamics 1 (4 Cr.). Programming 1 (4 Cr.). Programming 2 (4 Cr.). Programming 3 (4 Cr.). Digital Systems Design (6 Cr.). Introduction to Engineering Projects (2 Cr.). Linear Electrical Systems and Networks (6 Cr.). MATLAB (2 Cr.). Engineering at the Service of the Community (2 Cr.). USJ Values in Daily Life (2 Cr.).

Open Elective Courses (4 Cr.)

Bachelor of Engineering in Electrical Engineering
180 credits: Required courses (154 credits), Institution's elective courses (22 credits), Open elective courses (4 credits) and USJ General Education Program (26 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.). English (4 Cr.). Industrial Electronics (6 Cr.). Innovation and Design Thinking (2 Cr.). Linear Control (6 Cr.). Management (2 Cr.). Microprocessor Systems (4 Cr.). Modern Control (4 Cr.). Object-Oriented Programming (6 Cr.). Power Systems Analysis (4 Cr.). Project Management (4 Cr.). Renewable Energy (4 Cr.). Sensors and Instrumentation (4 Cr.). Signals and Systems (4 Cr.). Statistics (4 Cr.). Variable-Speed Drive Systems (6 Cr.). Corporate 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.). Power Generation (4 Cr.). Robotics (4 Cr.). Space and Micro/Nano Satellite Technologies (4 Cr.). System Identification (4 Cr.). Wheeled Robots (4 Cr.). Work Ready Now (2 Cr.).

Open Elective Courses (4 Cr.)

USJ General Education Program (10 out of 36 Cr.) - Honors Preparatory Electrical Engineering, Regular Preparatory ElectricalEngineering

26 additional credits are validated in the Department of Electrical and Mechanical Engineering

Code	Course Name	Credits
	HUMANITIES	**4**
064VALEL1	USJ Values in Daily Life	2
	Civic Engagement and Citizenship	**2**
020GSCCI1	Engineering at the Service of the Community	2
	QUANTITATIVE TECHNIQUES	**6**
020MADCI1	Discrete Mathematics	6

USJ General Education Program (26 out of 36 Cr.) - Bachelor of Engineering in Electrical Engineering

10 additional credits are validated in the Department of Preparatory Classes

Code	Course Name	Credits
	ENGLISH OR OTHER LANGUAGE	**4**
020ANGES4	English	4
	ARABIC	**4**
	Arabic Language and Culture	**2**
435LALML2 435LALAL2 435LRCTL2	One Arabic Culture and Language course to be selected among: Arabic Language and Media Arabic Language and Arts Arabic Language: Contemporary Novel, Cinema, and Theater	2
	Other Course Taught in Arabic	**2**
020DRAES5	Business Law	2
	HUMANITIES	**4**
	Ethics	**4**
020ETHES3	Business Ethics	4
	SOCIAL SCIENCES	**6**
	Professional Integration and/or Entrepreneurship	**2**
020ENTES1 020WRNES1	One Institution's elective course to be selected between: Entrepreneurship Work Ready Now	2
	Other Social Sciences Course	**4**
020GPRES2	Project Management	4
	COMMUNICATION TECHNIQUES	**8**
020TCOES2	Communication Skills	2
020PRMES4	Multidisciplinary Project	2 out of 6
020PFEES6	Final Year Project	4 out of 16

SUGGESTED STUDY PLAN

Students are required to choose either the Honors Preparatory track or the Regular Preparatory track. Once the two years of the chosen track are completed, they join the three-year Bachelor of Engineering program.

Semester 1

Code	Course Name	Credits
	Required Courses - Honors Preparatory Electrical Engineering	
020MADCI1	Discrete Mathematics	6
020GSCCI1	Engineering at the Service of the Community	2
020ANGCI1	General Analysis	6
020CHGCI1	General Chemistry	4
020MC1CI1	Mechanics 1	6
020SPHCI1	Physical Signals	6
	Total	**30**

	Required Courses - Regular Preparatory Electrical Engineering	
020MADNI1	Discrete Mathematics	6
020GSCNI1	Engineering at the Service of the Community	2
020ANGNI1	General Analysis	6
020CHGNI1	General Chemistry	4
020MC1NI1	Mechanics 1	6
020SPHNI1	Physical Signals	6
020CMTNI1	Supplemental Mathematics	2
	Total	**32**

Semester 2

Code	Course Name	Credits
	Required Courses - Honors Preparatory Electrical Engineering	
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**
	Required Courses - Regular Preparatory Electrical Engineering	
020AA1NI2	Analysis 1	4
020ALNNI2	Linear Algebra	8
020INMNI2	Magnetic Induction	2
020PP1NI2	Physics Laboratory 1	2
020IF1NI2	Programming 1	4
020TH1NI2	Thermodynamics 1	4
	Open Elective Course	2
	Total	**26**

Semester 3

Code	Course Name	Credits
	Required Courses - Honors Preparatory Electrical Engineering	
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**
	Required Courses - Regular Preparatory Electrical Engineering	
020AN2NI4	Analysis 2	6
020ALBNI3	Bilinear Algebra and Geometry	6
020EMENI3	Electromagnetism	4
020ITCNI3	Introduction to Heat Transfer	2
020MC2NI3	Mechanics 2	4
020PP2NI3	Physics Laboratory 2	2
020PRBNI4	Probability	4
020IF2NI3	Programming 2	4
	Total	**32**

Semester 4

Code	Course Name	Credits
	Required Courses - Honors Preparatory Electrical Engineering	
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**
	Required Courses - Regular Preparatory Electrical Engineering	
020CDFNI4	Differential Calculus	6
020TEDNI4	Digital Systems Design	6
020PIINI4	Introduction to Engineering Projects	2
020SRLNI4	Linear Electrical Systems and Networks	6
020MATNI4	MATLAB	2
020IF3NI4	Programming 3	4
064VALEL1	USJ Values in Daily Life	2
	Open Elective Course	2
	Total	**30**

Semester 5

Code	Course Name	Credits
	Required Courses - Bachelor of Engineering in Electrical Engineering	
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
	Required Courses - Bachelor of Engineering in Electrical Engineering	
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
	Required Courses - Bachelor of Engineering in Electrical Engineering	
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
	Required Courses - Bachelor of Engineering in Electrical Engineering	
020CCAES4	DC-AC Conversion	4
020ANGES4	English	4
020CTMES4	Modern Control	4
020PRMES4	Multidisciplinary Project	6
020EVVES4	Variable-Speed Drive Systems	6
	Institution's Elective Course	8
	Open Elective Course	2
	Total	**34**

Semester 9

Code	Course Name	Credits
	Required Courses - Bachelor of Engineering in Electrical Engineering	
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 Course	8
	Total	**30**

Semester 10

Code	Course Name	Credits
	Required Courses - Bachelor of Engineering in Electrical Engineering	
020PFEES6	Final Year Project	16
	Total	**16**

COURSE DESCRIPTION

Honors Preparatory Electrical Engineering

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; 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).

020AA1CI2 Analysis 1 4 Cr.

This course covers the following: Asymptotic analysis: Taylor series- Integration on a segment: integration and derivation- Riemann's sum- 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.

020AN2CI3 Analysis 2 6 Cr.

This course covers the following: Normed vector spaces: continuity, uniform continuity and Lipchitz 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 (020AA1CI2).

020AN3CI4 Analysis 3 4 Cr.

This course covers the series and summable families, sequences and series of functions, integration and derivation 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, Lagrange's method.
Prerequisite: Analysis 2 (020AN2CI3).

020TEDCI4 Digital Systems Design 4 Cr.

This course provides students with the opportunity to familiarize themselves with various methods of designing simple digital systems. They 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 the 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.

020MADCI1 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 (020SPHCI1) - General Analysis (020ANGCI1).

020GSCCI1 Engineering at the Service of the Community 2 Cr.

This course aims to explore the role of engineers in modern society, with a particular focus on innovation, renewable energies, green buildings, design, food security, recycling, and other areas relevant to our daily lives. Students will learn how engineers can leverage their technical skills, knowledge, and tools to address and solve social and environmental challenges through engineering.

020FR1CI2 French and Philosophy 1 2 Cr.

This course is offered to students in Higher Mathematics - Competition Section (Mathématiques supérieures - section Concours) to prepare them for the written French test in the admission competition for polytechnic schools (Filière Universitaire Internationale-Formation Francophone FUI-FF). Its objective is to provide students with the academic and didactic tools necessary for success in the admission test.

020FR2CI3 French and Philosophy 2 2 Cr.

This subject is offered to students in Advanced Mathematics - Competition Section (Mathématiques spéciales - section Concours) to prepare them for the written French test in the admission competition for polytechnic schools (Filière Universitaire Internationale-Formation Francophone FUI-FF). Its objective is to provide students with the academic and didactic tools necessary for success in the admission test.

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 analysis 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 generalizes the magnetic dipole of a current circuit 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 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.

020MC2CI3 Mechanics 2 4 Cr.

This course focuses on the study of specific topics within the field of classical mechanics. Its primary objective is to provide 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 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 (020MC1CI1).

020SPHCI1 Physical Signals 6 Cr.

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

020PP1CI2 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.

020PP2CI3 Physics Laboratory 2 2 Cr.

This course allows students to solidify their theoretical knowledge by putting it into practice through a variety of topics. They will have the opportunity to 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 (020PP1CI2).

020IF1CI2 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.

020IF2CI3 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 covers an introduction to relational databases.
Prerequisite: Programming 1 (020IF1CI2)

020IF3CI4 Programming 3 2 Cr.

This course covers the following: Ce 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 (020IF1CI2).

020PHQCI4 Quantum Physics 2 Cr.

This course is concerned with two aspects of modern physics. The first is based on the Schrodinger formulation of the 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 to be 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. Equipartition theorem is then used to evaluate heat capacity of gases and solids.
Prerequisite: Electromagnetism (020EMECI3).

020TRSCI3 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 have the opportunity to become familiar with digital filtering.

Prerequisite: Physical Signals (020SPHCI1).

020TIPCI4 Supervised Personal Initiative Work 2 Cr.

This course enables students to undertake a personal project focused on the scientific and technological research process. Emphasis is placed on the necessity of asking preliminary questions, mirroring the common practice of scientists. The research process leads to the creation of conceptual and real-world objects, promoting knowledge construction. Students will conduct concrete research, analyze reality, and identify an issue related to the theme. Explanations are obtained through investigation using traditional tools and methods of scientific research. The objective is to encourage students to make discoveries on their own, leveraging their inventive and initiative-taking abilities, without undue ambition.

020TH1CI2 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. It is in this course that the student understands, describes, and quantifies the operation of thermodynamic machines such as engines, refrigerators, and heat pumps.

020TH2CI4 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 (020TH1CI2).

064VALEL1 USJ Values in Daily Life 2 Cr.

This course aims to raise students' awareness of the fundamental values of the Saint Joseph University of Beirut (USJ) in order to apply them in their personal, interpersonal, and professional lives. It engages them in critical reflection on how the values outlined in the USJ Charter can influence their behaviors, actions, and decisions to meet the challenges of the contemporary world. They will also be aware of global issues and ethical responsibilities, ready to contribute positively to the construction of a better society.

020OPTCI3 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 (020SPHCI1).

Regular Preparatory Electrical Engineering

020AA1NI2 Analysis 1 4 Cr.

This course aims to develop a deep understanding of fundamental concepts in mathematical analysis and equip students with the ability to apply these tools to solve more advanced mathematical problems. It covers topics such as Taylor series expansions for approximating functions and studying their local behavior around a point. Students will also learn about anti-derivatives and improper integrals, gaining the skills to manipulate them effectively. Additionally, the course delves into the convergence or divergence of numerical series, teaching

students how to determine convergence using specific criteria. Overall, these topics prepare students to tackle complex mathematical problem-solving tasks.

020AN2NI4 Analysis 2 6 Cr.

This course aims to deepen the understanding of advanced concepts in mathematical analysis. It covers various areas, such as the pointwise and uniform convergence of sequences and series of functions. Additionally, it provides a detailed exploration of power series, studying their radii of convergence, properties, and their relation to analytic functions. Complex analysis is also introduced, offering a study of functions of a complex variable, which holds great importance in various applications of engineering. Finally, the course addresses Fourier series, which are used to represent periodic functions through linear combinations of sine and cosine functions. This in-depth knowledge prepares students to engage with more advanced concepts in applied mathematics, physics, engineering, and other related disciplines.
Prerequisite: Analysis 1 (020AA1NI2).

020ALBNI3 Bilinear Algebra and Geometry 6 Cr.

This course provides students with a solid understanding of fundamental concepts, including the reduction of endomorphisms, pre-Hilbert spaces and endomorphisms of Euclidean spaces. Throughout this course, students will develop proficiency in techniques for reducing matrices and endomorphisms, along with their practical applications such as calculating matrix powers, solving linear recurrent sequence systems and utilizing linear recurrent sequences to compute the matrix exponential. Additionally, the course examines pre-Hilbert spaces, placing emphasis on key notions such as the inner product, orthogonality and orthogonal projections. Students will learn how to apply these concepts in solving problems related to orthonormalization. Furthermore, the course covers the study of planar isometries, encompassing translations, rotations and reflections, as well as isometries in space. By engaging with these topics, students will acquire a strong foundation in bilinear algebra and the necessary skills to apply these concepts effectively in practical situations.
Prerequisite: Linear Algebra (020ALNNI2).

020CDFNI4 Differential Calculus 6 Cr.

This course is an in-depth exploration of differential equations and systems of ODEs. Fundamental concepts such as vector norms, subspaces, bases, and open and closed balls are thoroughly detailed. Then, students will explore the notions of convergence and equivalence between norms. The course also covers Topology by introducing fundamental concepts such as open and closed sets, adherent points, interior and boundary points. Then, a significant portion of the course is devoted to studying functions of several variables to explore concepts such as extrema and implicit functions. Finally, students will learn how to calculate double and triple integrals using various methods such as Cartesian, polar, and cylindrical coordinates. The concepts and techniques studied in this course are essential for developing advanced analytical skills and solving complex mathematical problems.
Prerequisite: General Analysis (020ANGNI1).

020TEDNI4 Digital Systems Design 6 Cr.

This course familiarizes students with various methods of designing simple digital systems. They 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 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.

020MADNI1 Discrete Mathematics 6 Cr.

This course covers the following: Propositional logic - Mathematical reasoning - Sets - Relations - Natural numbers, induction - Applications - Algebraic calculation - Binomial coefficient and Pascal triangle - Polynomials – Arithmetic.

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.
Prerequisites: General Analysis (020ANGNI1) - Physical Signals (020SPHNI1).

020GSCNI1 Engineering at the Service of the Community 2 Cr.

This course aims to explore the role of engineers in modern society, with a particular focus on innovation, renewable energies, green buildings, design, food security, recycling, and other areas relevant to our daily lives. Students will learn how engineers can leverage their technical skills, knowledge, and tools to address and solve social and environmental challenges through engineering.

020ANGNI1 General Analysis 6 Cr.

This course covers the fundamental concepts of analysis, including limits, continuity, differentiation, sequences, sets of numbers, and differential equations. Its objective is to equip students with the necessary skills to effectively calculate limits, perform differentiation and solve linear differential equations of both first and second order. In addition, this course allows the development of mathematical reasoning skills. Students will learn to formulate coherent arguments, justify calculation steps and prove mathematical results. By the end of this course, students will have gained a solid foundation in analysis enabling them to pursue more advanced courses in mathematics, physics, and engineering.

020CHGNI1 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 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 an 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 students to analyze potential-pH diagrams through examples along vertical and horizontal lines.

020PIINI4 Introduction to Engineering Projects 2 Cr.

This course aims to instill a sense of responsibility in students, akin to that of researchers and engineers, by introducing and cultivating their skills in the scientific research process. It also seeks to integrate scientific and technological research endeavors and facilitate the development of conceptual and tangible components that actively contribute to the continuous process of knowledge creation, spanning from ideation to design and, in some cases, realization.

020ITCNI3 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).

020ALNNI2 Linear Algebra 8 Cr.

This course enables students to manipulate complex numbers and explore their properties to perform calculations and solve equations. They will develop an understanding of geometric transformations such as translations,

rotations and homothety. This course introduces students to vector spaces and helps them understand concepts like linear independence, basis, and dimension. Linear transformations and matrices play a central role in this course. Students will examine the properties of linear transformations by learning how to find the kernel and image of these transformations and identify endomorphisms, automorphisms and isomorphisms. They will also learn to represent these transformations using matrices. Additionally, students will master the computation of determinants, which play a key role in the study of linear systems and their solutions. By acquiring this knowledge and these skills, students will be able to solve real-world problems and apply their knowledge in fields such as science, engineering, and computer science.

020SRLNI4 Linear Electrical Systems and Networks 6 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 are extensively covered to provide a comprehensive understanding of electrical circuits.
Prerequisite: Physical Signals (020SPHNI1).

020INMNI2 Magnetic Induction 2 Cr.

This course explores the fundamental principles of magnetic induction and its applications. It covers various topics such as magnetic fields, Faraday's law, electromagnetic induction, Lenz's law, transformers, etc. The course also addresses practical applications of magnetic induction, such as electric generators, electric motors, induction coils, magnetic sensors, etc. Students will acquire the necessary foundations to understand and analyze magnetic induction phenomena in various applications. These concepts are essential in many fields, including electrical engineering, electronics, electromagnetism, energy production, telecommunications, and more.

020MATNI4 MATLAB 2 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 have the opportunity to 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. Furthermore, the course provides an introduction to 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).

020MC1NI1 Mechanics 1 6 Cr.

This course studies particle mechanics, a branch of physics that analyzes the motion of objects as dimensionless mass points. This course simplifies physical systems by ignoring object dimensions and internal structure, focusing only on mass and position in space. This course applies Newton's laws to describe the relationship between applied forces, mass, and motion. This course enables students to analyze particle motion based on forces, mass, and initial conditions, providing a foundation for advanced concepts in classical mechanics, including kinematics, dynamics, laws of motion, and energy.

020MC2NI3 Mechanics 2 4 Cr.

This course studies solid mechanics, a branch of mechanics that examines the motion and equilibrium of objects considered as rigid bodies. This course covers the laws of mechanics for systems, focusing on solids, and shows how to determine the center of mass and study translational and rotational motion around a fixed axis. This course provides the definition of force systems and derived laws, allowing students to apply static, dynamic, and energetic principles to solve complex mechanical problems.
Prerequisite: Mechanics 1 (020MC1NI1).

020SPHNI1 Physical Signals 6 Cr.

This course enables students to understand the core principles pertaining to linear circuits and signal propagation. Throughout the course, students will delve into key concepts such as harmonic oscillators, progressive waves, interference, the fundamental laws of electrokinetics, complex notations, impedances and admittances, as well as linear filters. By the end of the course, students will possess the essential knowledge and skills required to effectively analyze and resolve challenges within these domains.

020PP1NI2 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.

020PP2NI3 Physics Laboratory 2 2 Cr.

This course allows students to reinforce their theoretical knowledge through practical applications across a variety of topics. They will have the opportunity to 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 (020PP1NI2).

020PRBNI4 Probability 4 Cr.

This course enables students to develop an understanding of the probability theory. It is designed to equip students with the necessary skills to effectively calculate probabilities. Throughout this course, students are introduced to various aspects of probability, beginning with combinatorics. They will learn techniques such as combinations, permutations and arrangements. Furthermore, they will explore concepts that enhance the understanding and manipulation of probabilities on a countable set. This includes the monotone convergence theorem, Boole's inequality, conditioning, compound probabilities, total probabilities and Bayes' formula. Additionally, the course emphasizes the study of discrete random variables, enabling students to model and analyze random phenomena using probability distributions. Finally, students will explore continuous random variables, with a focus on an extensive examination of cumulative distribution functions, expectation and variance.
Prerequisite: Analysis 1 (020AA1NI2).

020IF1NI2 Programming 1 4 Cr.

This course introduces the universal computer and the basic concepts of high-level programming using Python. Topics include: computer hardware components, algorithms, programming languages, Python and the IDLE environment, 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.

020IF2NI3 Programming 2 4 Cr.

This course allows the students to acquire advanced concepts of structured programming in Python. It also covers the basic concepts of object-oriented programming and their application to data abstraction and encapsulation by introducing the concepts of object instantiation, member visibility, inheritance, and polymorphism. Students will also learn how to create an ergonomic standalone graphical user interface using the standard tkinter library.
Prerequisite: Programming 1 (020IF1NI2).

020IF3NI4 Programming 3 4 Cr.

This course covers advanced programming concepts in Python. It includes a systematic study of existing sorting algorithms and how to calculate their time complexity. The course explores applying recursion to sorting algorithms with a recursive structure. It also covers file management for saving or reading structured or unstructured data, creating and manipulating relational databases, building command-line interfaces, using specialized libraries for scientific computing and data analysis, and connecting to remote sites to retrieve or submit data through programming interfaces (APIs).
Prerequisite: Programming 1 (020IF1NI2).

020CMTNI1 Supplemental Mathematics 2 Cr.

This course equips students with the necessary skills to solve elementary mathematical problems. They will learn key concepts such as composite and inverse functions, numerical sequences, circular functions, as well as definite and indefinite integrals. By studying composite and inverse functions, students will comprehend the relationships between different functions and learn to decompose and reconstruct more complex functions. Additionally, this course introduces numerical sequences, particularly arithmetic and geometric sequences. Another essential component of this course is the study of basic trigonometric functions: sine, cosine, and tangent. Finally, this course covers definite and indefinite integrals by exploring their properties, the technique of integration by parts, the substitution method, and a fundamental application: calculating areas.

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.

Bachelor of Engineering in Electrical Engineering

020CMPES5 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 (020SMPES3).

020ELAES1 Analog Electronics 6 Cr.

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

435LALAL2 Arabic Language and Arts 2 Cr.

This course offers a gradual immersion into the Arabic language and culture, enabling students to develop essential language skills while exploring a range of cultural topics.
Specific objectives:
- Explore diverse forms of Arabic artistic expression.
- Understand the significance of art within Arab culture and identity.

435LALML2 Arabic Language and Media 2 Cr.

This course offers a gradual immersion into the Arabic language and culture, enabling students to develop essential language skills while exploring a range of cultural topics.
Specific objectives:
- Understand the Arab media landscape and analyze its role in contemporary society.
- Develop critical media analysis skills in Arabic.

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

This course offers a gradual immersion into the Arabic language and culture, enabling students to develop essential language skills while exploring a range of cultural topics.
Specific objectives:
- Deepen knowledge of major Arabic literary and cinematic works.
- Develop critical analysis and debating skills in Arabic.

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 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 elaborated for each topology. Rating criteria based on the evaluation of the voltage and current stresses are elaborated.
In addition, different Pulse-Width-Modulation (PWM) control strategies are introduced and studied: carrier-based PWM, space-vector modulation, pre-calculated modulation, sigma-delta and delta modulations. Numerical simulations are performed to verify the theoretical concepts.
Prerequisite: DC-DC Conversion (020CCCES3).

020CCCES3 DC-DC Conversion 4 Cr.

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 elaborated for each topology. Rating criteria based on the evaluation of the voltage and current stresses are elaborated.
Prerequisite: Industrial Electronics (020ELIES2).

020CSMES4 Design of Mechatronic Systems 4 Cr.

This course 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 gates circuits, interfacing digital integrated circuits. Data converters basics: sampling, quantification, coding, analog switches, Overview of Analog-to-digital converter (ADC) and Digital-to-analog circuits (DAC) circuits (Resistive Weights, R/2R, SAR, Flash). Introduction to Memory Devices: terminology, architecture, ROM, SRAM, DRAM, Memory assembly.
Prerequisite: Analog Electronics (020ELAES1).

020SCNES3 Digital Systems and Control 4 Cr.

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

020MSDES1 Dynamic Systems Modeling 4 Cr.

This course explains the crucial importance of modeling and analysis in the industry nowadays that leads to performance improvement, better time management and manufacturing cost reduction of a given product. These goals are taught through examples of electrical, mechanical, thermal, and complex systems. Pre-sizing, modeling,

analysis of operation and performance are performed through simulations using the advanced software MATLAB/ Simulink. This course introduces engineering design to students through iterative improvements, feasibility study and process optimization before the usual industrial prototyping.
Prerequisite: MATLAB (020MATNI4).

020ME1ES2 Electric Machines 1 6 Cr.

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 NFC-150 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, luminaire – incandescent wire test, the bathrooms, Standards for electrical appliances in the bathroom, establishing an equipotential link. AutoCAD. Low voltage installation: ground connection diagrams, earth connections, connecting the transformer neutral to the earth, different types of electrical accidents, ground connection diagrams. power and minimum cross-section of a conductor, installed power, absorbed power, estimated installed power, utilization power, choice of transformer power rating, practical determination of the minimum cross-section of a conductor, voltage drop.
Prerequisite: Electrotechnics (020ETCES1).

020IE2ES3 Electrification 2 4 Cr.

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 tables, composition of electrical panels, types of electrical cables, thermal stress of the cables, selection of protective devices. Disturbances due to harmonics: harmonics, reminder of the Fourier Series, harmonic pollution, the effects of harmonics and resonance, IEC Standards in the fight against harmonics, basic solutions to attenuate harmonics, measurement of harmonics in electrical networks. Software for the design and sizing of LV electrical installations: ECODIAL, draw a single-line diagram, 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 isolation spark plugs.
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, magnetic materials used in electrotechnics, the operating and modeling of linear and nonlinear magnetic circuits without and with flux leakage and the effect of the airgap.
It also covers the modeling of three-phase balanced and unbalanced electrical networks operating in a sinusoidal regime by the method of the single-phase star equivalent scheme and the symmetrical components method. Finally, the principles of operation of single-phase and three-phase transformers are studied in order to establish their equivalent circuits and predetermine the values of the voltages, currents, powers, efficiency at no-load, short-circuit and load operations.
Prerequisites: Electromagnetism (020EMENI3 or 020EMECI3), Linear electrical systems and networks (020SRLNI4 or 020SRLCI4).

020SEMES3 Embedded Systems 4 Cr.

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: Digital Systems Design (020TEDNI4 or 020TEDCI4), Programming 1 (020IF1NI2 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, G02market strategy, Presentation – Basic budgeting and financial figures, Pitch deck, Presentation.

020PFEES6 Final Year Project 16 Cr.

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

020MEFES2 Fluid Mechanics 4 Cr.

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 and Bernoulli theorem - Navier-Stokes equations. Dimensional analysis applying the PI theorem.
Prerequisite: Mechanics 2 (020MC2CI3 or 020MC2NI3).

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. Type 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 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 - psychometric chart: calculation and dimensioning of heating, cooling, humidifying, and dehumidifying systems for interior environment - load estimation for heating, taking into account the impacts of ventilation, wall insulation, glazing treatment, lighting and equipment heating production - 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 psychometric chart of heating coils, humidifiers, air filters, fans, and mixing box.
Prerequisites: Fluid Mechanics (020MEFES1) or Fluid Mechanics 1 (020MF1ES1), Thermodynamics 2 (020TH2CI4) or Introduction to Heat Transfer (020ITCNI3 or 020THENI3).

020CL2ES4 HVAC 2 4 Cr.

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

020GINES5 Industrial Engineering 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 optimum 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 type (input, output, digital, analog) – SCADA architecture (field level, automation level, management level) – Intelligent Electronic Devices (IED) – Communication (message, sender, receiver, master, slave, serial, parallel) – Transmission (simplex, duplex, point to point, multipoint, guided, unguided) – Topology (mesh, star, bus, ring, hybrid) – Transmission media (twisted pair, coaxial, patch cable, crossover cable, fiber optic) – Data coding – Operational Block (OB) – Function (FC) – Function Block (FB) – DataBlock (DB) – Scan cycle – Interrupt – MODBUS data types (discrete input, coil, input register, holding register).

020INDES2 Innovation and Design Thinking 2 Cr.

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

020AULES2 Linear Control 6 Cr.

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

020MLRES4 Machine Learning 4 Cr.

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.

020SMPES3 Microprocessor Systems 4 Cr.

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

020CCIES4 Mixed-Signal IC Design 4 Cr.

This course introduces the use of an industrial EDA Software tool to acquire computer-Aided Design skills in the field of Integrated Circuit Design. Topics covered include: ic design flow, fabrication technology and packaging. multi-stage amplifiers, current mirrors and active loads, basic biasing concepts, differential signaling, operational amplifier transistor-level design, filters, sampled circuits, buffers, frequency response of analog feedback circuits, introduction to stability of feedback amplifiers, simulation and evaluation of the electrical performance of ics using eda software. introduction to noise and linearity in electronics.
Prerequisite: Digital Electronics (020ELNES2).

020CTMES4 Modern Control 4 Cr.

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

020PRMES4 Multidisciplinary Project 6 Cr.

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

020SNLES5 Nonlinear Systems 4 Cr.

This course is divided into two parts. The first part presents two analysis methods of nonlinear systems. The first method, characterized by its simplicity, is based on the describing function concept in the frequency domain. It makes use of basic elements already seen in linear systems analysis and control, which are extended to the nonlinear case. The second method is more rigorous and uses the concept of state variables and phase plane in the time domain. The stability theory of nonlinear systems 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 control 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: Linear Algebra (020ALNNI2) or Algebra 1 (020AL1CI2), Differential Calculus (020CDFNI4) 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. Compiling with CMake. Code versioning with git and github.
Prerequisite: Programming 2 (020IF2CI3 or 020IF2CI3).

020OPTES5 Optimization 4 Cr.

This course introduces optimization techniques tailored for electrical engineers. Students will learn to identify electrical engineering problems and formulate them as optimization problems by selecting appropriate objective functions and constraints and applying optimization algorithms to find optimal solutions. Topics include linear and nonlinear optimization, convex optimization, and heuristic methods.
Emphasis is placed on understanding mathematical foundations, algorithmic implementations, and practical applications in electrical engineering systems. 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 minimum.

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).

020PENES4 Power Generation 4 Cr.

This course is designed to provide students with a deep insight into the various technologies and methodologies used to generate electrical power. It encompasses theoretical principles, practical applications, and the environmental considerations associated with power generation, 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 Fluid Mechanics 1 (020MF1ES1).

020ANRES4 Power Systems Analysis 4 Cr.

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

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 teaching students these successful techniques, and exposing 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 potentials and unique characteristics of renewable energies, particularly in the area of electricity generation. The course addresses key questions such as the nature of these energy resources, methods for their capture and transformation, and the various forms in which they can be utilized.
Throughout the program, students will explore specific topics, including the principles of solar radiation, 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 from the sensors, actuators, and closed loop representation, going through dynamics and kinematics equations, and reaching 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-based (MATLAB, LabVIEW, etc.) and emphasized in this course.

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: Differential Calculus (020CDFNI4) or Analysis 2 (020AN2CI3).

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

This course covers the following: Micro/nano satellite mission, orbits design and analysis, subsystem scheme, micro/nano satellite configuration design, system performance determination and analysis, reliability and safety analysis technical processes of 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 softwares, STK tracker software, design and implement (tabletop) a nanosatellite of type Cubesat 1U using commercial components and boards.
Prerequisites: Analog Electronics (020ELAES1) and Mechanics 1 (020MC1NI1 or 020MH1NI1).

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 (020PRBNI4) or Algebra 3 (020AL3CI4).

020IPRES5 System Identification 4 Cr.

This course includes the following: Course introduction. Plants and systems models: type of models and representation methods. Identification of nonparametric models in the time and frequency domains: correlation method, Fourier analysis, spectral analysis, closed loop identification. Pseudo-random binary signal: properties and design for identification purposes. Parametric models' identification: least squares technique, recursive, weighted, instrumental variables, etc. MATLAB Identification Toolbox. Workshops using MATLAB/Simulink. Experimental identification and control of a linear system.

Prerequisite: Digital systems and control (020SCNES3).

020EVVES4 Variable-Speed 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 kinematics constraints; (ii) modelling: kinematics, dynamics, and state-space representation; (iii) nonlinear control strategies (open-loop and closed-loop), and (iv) simulation using the virtual wheeled mobile robots laboratory. Four architectures are covered: differential-drive robot, Ackermann-based steering robot, Articulated-based steering robot, and mobile wheeled pendulum.

020WRNES1 Work Ready Now 2 Cr.

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