# BACHELOR OF ENGINEERING IN MECHANICAL ENGINEERING

**Concentrations: Mechatronics, Energy, Mechanical Design**

**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 Mechanical Engineering**
The Mechanical 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 Mechanical Engineering**
The Mechanical 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 Mechanical Engineering**
The Bachelor of Engineering in Mechanical 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 Mechanical 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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**Competencies – Bachelor of Engineering in Mechanical Engineering**
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- The ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- The ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

## PROGRAM REQUIREMENTS

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 Mechanical 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.). Computer Assisted Drawing (2 Cr.). Linear Electrical Systems and Networks (4 Cr.). Statics for Mechanical Engineering (2 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 Mechanical 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.). Introduction to Materials Science (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.). Computer Assisted Drawing (4 Cr.). Introduction to Engineering Projects (2 Cr.). Linear Electrical Systems and Networks (6 Cr.). MATLAB (2 Cr.). Statics for Mechanical Engineering (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 Mechanical Engineering**
180 credits: Required courses (158 credits), Institution's elective courses (18 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-Common Core (142 Cr.)**
Accounting (4 Cr.). Automobile (4 Cr.). Business Ethics (4 Cr.). Business Law (2 Cr.). Communication Skills (2 Cr.). Computer Aided Drawing and Design (CADD) (4 Cr.). C++ Programming (4 Cr.). Electronics (6 Cr.). Finite Elements for Mechanical Applications (4 Cr.). Fluid Mechanics (6 Cr.). Heat Transfer (6 Cr.). HVAC 1 (4 Cr.). Hydraulics (4 Cr.). Innovation and Design Thinking (2 Cr.). Introduction to Electric Machines (4 Cr.). Linear Control (6 Cr.). Machine Design 1 (4 Cr.). Management (2 Cr.). Mechanical Systems (6 Cr.). Mechanical Vibrations (4 Cr.). Numerical Methods (4 Cr.). Plumbing (4 Cr.). Project Management (4 Cr.). Renewable Energy for Mechanical Engineering (4 Cr.). Sensors and Instrumentation (4 Cr.). Statistics (4 Cr.). Strength of Materials (6 Cr.). Thermodynamics: Principles and Applications (6 Cr.). Corporate Internship (2 Cr.). Multidisciplinary Project (6 Cr.). Final Year Project (16 Cr.).

**Required Courses-Concentration: Energy (16 Cr.)**
HVAC 2 (4 Cr.). Power Generation (4 Cr.). Thermal Engines (4 Cr.). Turbomachines (4 Cr.).

**Required Courses-Concentration: Mechanical Design (16 Cr.)**
Advanced Strength of Materials (4 Cr.). Design of Mechanisms (4 Cr.). Manufacturing Processes 1 (4 Cr.). Selection and Properties of Materials (4 Cr.).

**Required Courses-Concentration: Mechatronics (16 Cr.)**
Design of Mechatronic Systems (4 Cr.). Micro-Electro-Mechanical Systems (MEM) (4 Cr.). Microprocessors for Mechatronic Applications (4 Cr.). Modern Control (4 Cr.).

**Institution's Elective Courses (18 Cr.), to be chosen from the list below:**
Courses are to be selected from the required courses of the other two concentrations or from the following list: English (4 Cr.). Acoustics and Vibrations (4 Cr.). Advanced Materials Science (4 Cr.). Aerodynamics (4 Cr.). Artificial Intelligence (4 Cr.). Automotive Propulsion Systems (4 Cr.). Biomechanics (4 Cr.). Dynamic Systems Modeling (4 Cr.). Energy Optimization (4 Cr.). Entrepreneurship (2 Cr.). Fluid Power Systems (4 Cr.). Home Automation (4 Cr.). Hydraulic Servo Systems (4 Cr.). Machine Design 2 (4 Cr.). Machine Learning (4 Cr.). Manufacturing Processes 2 (4 Cr.). Mechanics of Composite Materials (4 Cr.). Mechatronics and Intelligent Machines (4 Cr.). Numerical Fluid Mechanics (CFD) (4 Cr.). Pollution, Environment and Sustainability (4 Cr.). Profitability of Energy Projects (4 Cr.). Refrigeration Systems (4 Cr.). Robotics (4 Cr.). Wheeled Robots (4 Cr.). and Work Ready Now (2 Cr.).

**Open Elective Courses (4 Cr.)**

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

*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 Mechanical 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<br>435LALAL2<br>435LRCTL2 | One Arabic Culture and Language course to be selected among:<br>Arabic Language and Media<br>Arabic Language and Arts<br>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<br>020WRNES1 | One Institution's elective course to be selected between:<br>Entrepreneurship<br>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 Mechanical 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 Mechanical 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 Mechanical 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 Mechanical Engineering** | |
| 020AA1NI2 | Analysis 1 | 4 |
| 020ISMNI2 | Introduction to Materials Science | 2 |
| 020ALNNI2 | Linear Algebra | 8 |
| 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 Mechanical 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 Mechanical 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 Mechanical Engineering** | |
| 020AL3CI4 | Algebra 3 | 4 |
| 020AN3CI4 | Analysis 3 | 4 |
| 020DISCI4 | Computer Assisted Drawing | 2 |
| 020SRLCI4 | Linear Electrical Systems and Networks | 4 |
| 020IF3CI4 | Programming 3 | 2 |
| 020PHQCI4 | Quantum Physics | 2 |
| 020STMCI4 | Statics for Mechanical Engineering | 2 |
| 020TIPCI4 | Supervised Personal Initiative Work | 2 |
| 020TH2CI4 | Thermodynamics 2 | 2 |
| 064VALEL1 | USJ Values in Daily Life | 2 |

| | | |
|---|---|---|
| | **Total** | **26** |
| | **Required Courses - Regular Preparatory Mechanical Engineering** | |
| 020DAMNI4 | Computer Assisted Drawing | 4 |
| 020CDFNI4 | Differential Calculus | 6 |
| 020PIINI4 | Introduction to Engineering Projects | 2 |
| 020SRLNI4 | Linear Electrical Systems and Networks | 6 |
| 020MATNI4 | MATLAB | 2 |
| 020IF3NI4 | Programming 3 | 4 |
| 020STMNI4 | Statics for Mechanical Engineering | 2 |
| 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 Mechanical Engineering-Common Core** | |
| 020PCPES2 | C++ Programming | 4 |
| 020ELCES1 | Electronics | 6 |
| 020MEFES1 | Fluid Mechanics | 6 |
| 020STAES1 | Statistics | 4 |
| 020RDMES1 | Strength of Materials | 6 |
| 020TPAES1 | Thermodynamics: Laws and Applications | 6 |
| 020WRNES1<br>**or**<br>020ENTES1 | Institution's Elective Course:<br>Work Ready Now<br>**or**<br>Entrepreneurship | 2 |
| | **Total** | **34** |

### Semester 6

| Code | Course Name | Credits |
|---|---|---|
| | **Required Courses - Bachelor of Engineering in Mechanical Engineering** | |
| 020TCOES4 | Communication Skills | 2 |
| 020TRCES2 | Heat Transfer | 6 |
| 020CL1ES3 | HVAC 1 | 4 |
| 020IMEES1 | Introduction to Electric Machines | 4 |
| 020SMEES1 | Mechanical Systems | 6 |
| 020VMEES2 | Mechanical Vibrations | 4 |
| 020MENES1 | Numerical Methods | 4 |
| | Open Elective Course | 2 |
| | **Total** | **32** |

### Semester 7

| Code | Course Name | Credits |
|---|---|---|
| | **Required Courses - Bachelor of Engineering in Mechanical Engineering** | |
| 020AUTES3 | Automobile | 4 |
| 020CAOES2 | Computer Aided Drawing and Design (CADD) | 4 |
| 020HYDES3 | Hydraulics | 4 |
| 020AULES2 | Linear Control | 6 |
| 020CM1ES3 | Machine Design 1 | 4 |
| 020CEIES3 | Sensors and Instrumentation | 4 |
| | **Required Courses-Concentration: Energy** | |
| 020CL2ES4 | HVAC 2 | 4 |
| 020TRBES3 | Turbomachines | 4 |
| | **Required Courses-Concentration: Mechanical Design** | |
| 020CPMES3 | Design of Mechanisms | 4 |
| 020PF1ES3 | Manufacturing Processes 1 | 4 |
| | **Required Courses-Concentration: Mechatronics** | |
| 020MEMES5 | Micro-Electro-Mechanical Systems (MEM) | 4 |
| 020MAMES3 | Microprocessors for Mechatronic Applications | 4 |
| | **Total** | **34** |

### Semester 8

| Code | Course Name | Credits |
|---|---|---|
| | **Required Courses - Bachelor of Engineering in Mechanical Engineering** | |
| 020ETHES3 | Business Ethics | 4 |
| 020PRMES4 | Multidisciplinary Project | 6 |
| 020GPRES2 | Project Management | 4 |
| 020PLBES4 | Plumbing | 4 |
| | Institution's Elective Course | 8 |
| | Open Elective Course | 2 |
| | **Required Courses-Concentration: Energy** | |
| 020MOTES4 | Thermal Engines | 4 |
| | **Required Courses-Concentration: Mechanical Design** | |
| 020RMAES4 | Advanced Strength of Materials | 4 |
| | **Required Courses-Concentration: Mechatronics** | |
| 020CTMES4 | Modern Control | 4 |
| | **Total** | **32** |

### Semester 9

| Code | Course Name | Credits |
|---|---|---|
| | **Required Courses - Bachelor of Engineering in Mechanical Engineering** | |
| 020CMPES5 | Accounting | 4 |
| 020DRAES5 | Business Law | 2 |
| 020STGES5 | Corporate Internship | 2 |

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|---|---|---|
| 020ELFES4 | Finite Elements for Mechanical Applications | 4 |
| 020INDES2 | Innovation and Design Thinking | 2 |
| 020MNGES5 | Management | 2 |
| 020ERMES5 | Renewable Energy for Mechanical Engineering | 4 |
| | Institution's Elective Course | 8 |
| | **Required Courses-Concentration: Energy** | |
| 020PENES4 | Power Generation | 4 |
| | **Required Courses-Concentration: Mechanical Design** | |
| 020SPMES4 | Selection and Properties of Materials | 4 |
| | **Required Courses-Concentration: Mechatronics** | |
| 020CSMMS4 | Design of Mechatronic Systems | 4 |
| | **Total** | **32** |

**Semester 10**

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

## COURSE DESCRIPTION

**Honors Preparatory Mechanical 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 equation and systems of the form X'=A(t)X+B(t), the method of constant variation, Lagrange's method.
**Prerequisite:** Analysis 2 (020AN2CI3).

**020DAMCI4 Computer Assisted Drawing 2 Cr.**

This course covers the following: Drawing on AutoCAD. Classification of drawings. Standardization. Presentation of drawings. Methods of executing a drawing. Geometric constructions. Connections. Common curves. Presentation of solids. Dimensioning. Cross-sections. Sections. Surface states. Tolerances and fits. Functional dimensioning. Assembly drawing. Modes of mechanical connections. Means of mechanical connections and technological elements. Symbolic representation.

**020MADCI1 Discrete Mathematics 6 Cr.**

This course covers the following: Logic and reasoning, Set theory, Applications, Binary relations, Algebraic calculations, Complex numbers, Integer arithmetic, 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 Maxwell's 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, wave length, 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 based on the Schrodinger formulation of the wave mechanics and is treat 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 discreet 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).

**020STMCI4 Statics for Mechanical Engineering 2 Cr.**

This course introduces the principles required to solve engineering problems through statics. It applies concepts from basic mathematics and physics to the modeling and analysis of static equilibrium, with an emphasis on real-world engineering applications and problem solving. The course studies methods for quantifying forces between bodies and defining their equilibrium. It explains how forces maintain balance and cause motion or changes in shape, which are critical to the functionality of objects and structures. Students will understand why statics is an essential prerequisite for many engineering fields, particularly civil and mechanical engineering, where the effects of forces are fundamental.
**Prerequisite:** Mechanics 1 (020MC1CI1).

**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 Mechanical 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 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).

**020DAMNI4 Computer Assisted Drawing 4 Cr.**

This course covers the following: Drawing on AutoCAD. Classification of drawings. Standardization. Presentation of drawings. Methods of executing a drawing. Geometric constructions. Connections. Common curves. Presentation of solids. Dimensioning. Cross-sections. Sections. Surface states. Tolerances and fits. Functional dimensioning. Assembly drawing. Modes of mechanical connections. Means of mechanical connections and technological elements. Symbolic representation.

**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).

**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 equations. Following the presentation of the Maxwell 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 the analysis of 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).

**020ISMNI2 Introduction to Materials Science 2 Cr.**

This course begins with an introduction to materials and chemical bonds. It allows students to master the structure of solid, amorphous and crystalline materials with their chemical compositions and crystal defects. Then the properties of the materials (physical, chemical and mechanical) and the phenomena of degradation will be approached (ageing, deterioration, corrosion, etc.) in addition to the use of the materials. Finally, the materials are divided into three main parts and explained: metallic materials (alloys, cast iron and steel), polymer materials and mineral materials. Examples of common applications are discussed after each part in order to familiarize students with the links between structure and properties sought in mechanical engineering.

**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).

**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 also 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).

**020STMNI4 Statics for Mechanical Engineering 2 Cr.**

This course introduces the principles required to solve engineering problems through statics. It applies concepts from basic mathematics and physics to the modeling and analysis of static equilibrium, with an emphasis on real-world engineering applications and problem solving. The course studies methods for quantifying forces between bodies and defining their equilibrium. It explains how forces maintain balance and cause motion or changes in shape, which are critical to the functionality of objects and structures. Students will understand why statics is an essential prerequisite for many engineering fields, particularly civil and mechanical engineering, where the effects of forces are fundamental.
**Prerequisite:** Mechanics 1 (020MC1NI1).

**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.

**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.

**Bachelor of Engineering in Mechanical 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.

**020AEVES4 Acoustics and Vibrations 4 Cr.**

This course covers the fundamental concepts in noise and vibrations, the vibrations of bars, beams, and membranes, passive and active damping strategies, damping materials, control methods; and applications.
**Prerequisite:** Mechanical Vibrations (020VMEES2) or Vibrations (020VIBES2).

**020SMAES4 Advanced Materials Science 4 Cr.**

This course deals with metals and polymers. The ferrous and non-ferrous alloys section covers the following aspects: mechanical behavior of metals, phase diagrams; fabrication of metals, heat treatment, surface properties of metals; plastic deformation, elements of fracture mechanics; and process-structure-property relationships. The polymers' part covers their properties, polymerization and synthesis, characterization techniques, physical properties of polymers, viscoelasticity, mechanical properties and applications.
**Prerequisite:** Introduction to Materials Science (020ISMNI2).

**020RMAES4 Advanced Strength of Materials 4 Cr.**

This course focuses on the study of stresses resulting from combined loadings, beam deflection, principal stresses, and absolute maximum shear stress. It also covers experimental methods for determining deformation, column buckling, and static failure theories. Students will explore statically indeterminate problems, which are common in real-world scenarios and cannot be solved using statics alone. The course introduces various solution methods,

including integration, superposition, and Clapeyron's theorem, to determine reactions at the supports of statically indeterminate members under tension, torsion, bending, and buckling. Additionally, the course covers the virtual work theorem, energy methods, static failure theories, and the three-dimensional state of stress using Mohr's circle. Topics also include stresses in thin-walled pressure vessels, composite and curved beams, shear centers, and asymmetric bending. The course further addresses the plastic analysis of bars, beams, and shafts with elastic-perfectly plastic material, as well as two-dimensional problems in elasticity.
**Prerequisite:** Strength of Materials (020RDMES1) or Strength of Materials 1 (020RM1ES2).

**020ARDES3 Aerodynamics 4 Cr.**

This course covers theoretical and empirical methods for calculating the loads on airfoils and finite wings by application of classical potential theory, thin airfoil approximations, lifting line and lifting surface theory, and panel methods; wings and airplanes; application of linearized supersonic flow to supersonic airfoils; performance and constraint analysis; longitudinal stability and control.
**Prerequisite:** Fluid Mechanics (020MEFES1) or Fluid Mechanics 1 (020MF1ES1).

**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.

**020IA3ES4 Artificial Intelligence 4 Cr.**

This course aims to study artificial intelligence agents. It presents several methods of implementing these agents: from simple reflex agents to utility-based agents as well as learning agents. It first covers greedy search and A search*, the implementation of games through the Minimax and Expectimax algorithms, Markov Decision Processes (MDP) and Reinforcement Learning (RL). This course then introduces Machine Learning (ML) algorithms with some applications such as regression and classification. Finally, these algorithms are applied to realistic datasets via Python implementations using libraries such as Scikit-learn, Tensorflow and Keras.

**020AUTES3 Automobile 4 Cr.**

This course introduces students to automotive engineering, it deals with several systems in an automobile such as clutches, manual and automatic gearboxes, torque converter, 4x4 transfer, CV joints, transmission, differential, suspension, wheel geometry, steering box, and braking systems.
**Prerequisite:** Mechanical Systems (020SMEES1) or Mechanical Structures (020STMES1).

**020SPAES5 Automotive Propulsion Systems 4 Cr.**

This course covers the basics of transmission systems and ground propulsion, energy consumption and the environmental impact of modern means of transport, configuration of conventional vehicle propulsion systems, principles of operation of conventional propulsion systems, technologies of propulsion systems for battery electric vehicles, technologies of propulsion systems of fuel cell vehicles, hybrid electric powertrain technologies, stop/start of hybrid, parallel hybrid and series/parallel hybrid drive systems.
**Prerequisites:** Automobile (020AUTES3), Thermal Engines (020MOTES4).

**020BIMES3 Biomechanics 4 Cr.**

This course explores the biomechanical principles underlying the kinetics and kinematics of both normal and abnormal human motion, with an emphasis on the interaction between biomechanical and physiological factors (bones, joints, connective tissues, and muscle physiology and structure) in skeletal and motor function. It also covers applications in testing and rehabilitation practice. Additionally, the course introduces constitutive equations, stress-strain relationships for biomaterials, rheological properties of blood, and the biomechanics of blood vessels and the heart.
**Prerequisites:** Introduction to Materials Science (020ISMNI2), Mechanical Systems (020SMEES1).

**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 wishing 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.

**020CAOES2 Computer Aided Drawing and Design (CADD) 4 Cr.**

This course covers computer aided drawing and design (CADD). Students will employ these powerful tools in the solution of various mechanical engineering problems. CADD includes all the modeling programs and techniques that allow the design of models and products. It also makes it possible to simulate and therefore virtually test products before manufacturing them so that it is then easy to transmit the information to Computer Aided Manufacturing (CAM). The course also enables students to identify several stages: (a) Creation of a model of the object, (b) Analysis, testing and simulations, (c) Construction of virtual prototypes, (d) Management of large assemblies. It utilizes SolidWorks software for drawing, analysis, design, and testing of mechanical systems and applications.

**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.

**020PCPES2 C++ Programming 4 Cr.**

This course covers the following: Structure of a C++ program (declarations, statements, literals, operators), control statements (conditional statements and loops), functions, arrays, structures. Object-oriented programming: Classes and objects, construction, encapsulation, inheritance, virtual functions, abstract classes and polymorphism, operator overloading, exception handling, file handling, generic programming with templates, the Standard Template Library (STL), graphical interfaces with Qt.
**Prerequisite:** Programming 2 (020IF2NI3 or 020IF2CI3).

**020CPMES3 Design of Mechanisms 4 Cr.**

This course focuses on the graphical and analytical synthesis of linkage mechanisms to one or more loops for the generation of movements, trajectories and generation of functions from 2-3-4 and 5 precision positions; optimal synthesis of linkage mechanisms; synthesis of cam-follower mechanisms; synthesis of gear trains.
**Prerequisite:** Mechanical Systems (020SMEES1).

**020CSMMS4 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.
**Prerequisites:** Sensors and Instrumentation (020CEIES3), Microprocessors for Mechatronic Applications (020MAMES3).

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

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

**020ELCES1 Electronics 6 Cr.**

This course introduces the basics of electronics and electronic circuits to students in the mechanical engineering program. Its objectives are to provide a concise treatment of the basic concepts of electronic components and to introduce students to basic analog and digital circuits. The course covers the basics of diodes, semiconductors, transistors, operational amplifiers and their applications, digital circuits and systems, and basic instrumentation.
**Prerequisite:** Linear Electrical Systems and Networks (020SRLNI4 or 020SRLCI4).

**020OEPES5 Energy Optimization 4 Cr.**

This course examines the energy audit methods for industrial processes and the systematic mathematical methods of energy efficiency and energy, economic and environmental optimization of these processes by the application of the pinch method. The pinch method is a relatively recent method (it dates back to the 1980s), which makes it possible to determine the most efficient network of heat exchangers and utilities in an energy installation or an industrial process. It is based on thermodynamic principles and on the study of the thermal heat transfer

between the streams to be cooled (availability) and heated (needs). It makes it possible to minimize the internal irreversibility of the heat exchanger network, and thus to improve its performance.
**Prerequisite:** Heat Transfer (020TRCES2).

**020ANGES4 English 4 Cr.**

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

**020ENTES1 Entrepreneurship 2 Cr.**

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

**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 review 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.

**020ELFES4 Finite Elements for Mechanical Applications 4 Cr.**

This course covers the finite element method that is a widely used numerical simulation technique in engineering and research across various technical and scientific fields. It introduces students to the theoretical foundations and numerical implementation of the finite element method, with a focus on problems in the mechanics of materials and heat transfer. Students will learn to solve second-order differential equations in one and two dimensions with one or two variables. The course covers the stiffness method and/or weak formulations to derive finite element models. Applications include problems involving bars, trusses, beams, heat exchangers, frames, and plane stresses and strains in elasticity. Both symmetric and asymmetric problems are also addressed. Additionally, the course enables students to effectively use finite element software (Abaqus) and interpret and validate results.
**Prerequisites:** Numerical Methods (020MENES1), Strength of Materials (020RDMES1) or Strength of Materials 1 (020RM1ES2).

**020MEFES1 Fluid Mechanics 6 Cr.**

This course provides an in-depth understanding of fluid mechanics principles and their applications in mechanical engineering. Students will explore the fundamental concepts of fluid behavior, fluid statics, fluid dynamics, and the practical aspects of fluid flow in mechanical processes. The course emphasizes the analysis and design of fluid systems, including the fundamental elements for understanding incompressible and compressible fluid flow using the principles of mass, momentum, energy conservation principles and resolution of the characteristic fluid flow equations through analytical and analogous methods.
**Prerequisite:** Mechanics 2 (020MC2CI3 or 020MC2NI3).

**020OFPES4 Fluid Power Systems 4 Cr.**

This course provides an overview of the latest technologies and developments in fluid power systems, as well as the diversity of their applications. It explains the potential and specificities of applying different systems and components in the engineering world, from aviation to industrial machinery. The covered topics include technology, operation, maintenance, troubleshooting, design, and analysis of different fluid power systems and their components, such as positive displacement pumps and motors, hydraulic actuators and servomechanisms,

various types of valves (pressure and flow regulating valves), selector valves, servo-valves, filtration and fluid conditioning systems, and electric and automatic control components and sensors for different fluid power systems.
**Prerequisites:** Hydraulics (020HYDES3), Computer Assisted Drawing (020DAMNI4 or 020DAMCI4).

**020TRCES2 Heat Transfer 6 Cr.**

The course covers the fundamental concepts and conduction, convection and heat transfer by radiation, as well as their application to the solution of thermal engineering problems. The course also covers stationary thermal conduction and transient regime; flat surfaces; numerical simulations of conduction in one-dimensional and two-dimensional problems; external and internal forced convection applied to laminar and turbulent flows; natural convection; principles of the heat exchanger; and thermal radiation, form factors and radiation exchange between diffuse and gray surfaces.
**Prerequisite:** Introduction to Heat Transfer (020ITCNI3 or 020THENI3) or Thermodynamics 2 (020TH2CI4).

**020DOMES3 Home Automation 4 Cr.**

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

**020CL1ES3 HVAC 1 4 Cr.**

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, Dehumidifying systems for interior ambient - Load Estimation for Heating taking into account the Impacts of Ventilation, Wall insulation, Glazing treatment, Lighting and Equipment heating production, etc. - Central Heating using Hot Water: Presentation, Design and sizing of radiators, Fan-coils, Floor heating, Convectors, Pipes, Pumps, Boilers, Burners, Domestic hot water, Fuel tanks, Chimney, etc. - Heating with Hot Air: Production of hot air, Air handling unit, Fan coil unit - Presentation, Design and sizing using the psychometric chart of heating coils, Humidifiers, Air filters, Fans, Mixing box.
**Prerequisites:** Fluid Mechanics (020MEFES1) or Fluid Mechanics 1 (020MF1ES1), Thermodynamics 2 (020TH2CI4) or Introduction to Heat Transfer (020ITCNI3 or 020THENI3).

**020CL2ES4 HVAC 2 4 Cr.**

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 sheet – Cold battery and air evolution on cold batteries – Direct and indirect expansion air conditioning modes – Low and high-speed duct systems – Single and double flow and variable air flow.
**Prerequisite:** HVAC 1 (020CL1ES3).

**020HYDES3 Hydraulics 4 Cr.**

This course focuses on steady-state and transient flows. Based on an in-depth approach to pressure losses, special attention is paid to the design of simple and complex networks. The safety of networks is approached by the study of transient regimes and the sizing of adequate protections. Extended network analysis is undertaken by studying pumps and turbines.
**Prerequisite:** Fluid Mechanics (020MEFES1) or Fluid Mechanics 1 (020MF1ES1).

**020SSHES5 Hydraulic Servo Systems 4 Cr.**

This course covers the fundamentals of modeling and control of hydraulic servosystems. It provides theoretical background and practical techniques for the modeling, identification and control of hydraulic servo systems. Classical and advanced control algorithms are discussed. The use of MATLAB/Simulink and other programming languages will be an integral part of this course.
**Prerequisites:** Fluid Mechanics (020MEFES1) or Fluid Mechanics 1 (020MF1ES1), Linear Control (020AULES2).

**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.

**020IMEES1 Introduction to Electric Machines 4 Cr.**

This course introduces the following topics: Magnetic materials and circuits - Three-phase regimes - Constitution, modeling, and steady-state operation of the DC machine - Concept of rotating field - Constitution, equivalent diagrams, and steady-state operation of the asynchronous and synchronous machines.
**Prerequisite:** Electromagnetism (020EMENI3 or 020EMECI3).

**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).

**020CM1ES3 Machine Design 1 4 Cr.**

This course covers fundamental mechanical design topics, such as static and fatigue failure theories, analysis of shafts, bearings and gears. In addition to fatigue failure criteria and S-N diagrams, it also covers surface failure, contact stresses, and static and fatigue stress concentrations. Students will learn to design the common elements of the machines which are studied by emphasizing their behavior under static and dynamic loads. The elements concerned in this course are represented by the transmission shaft, the keys and the couplings, the bearings and lubrication, and the spur gears.
**Prerequisites:** Strength of Materials (020RDMES1) or Strength of Materials 1 (020RM1ES2), Mechanical Systems (020SMEES1).

**020CM2ES4 Machine Design 2 4 Cr.**

This course is a continuation of Machine Design 1. Students will further develop their skills in designing and sizing mechanical components in machines, including helical, bevel, and worm gears, as well as brakes, clutches, flywheels, and flexible mechanical elements. The course also covers the design of tension, compression, and torsion springs, screws and fasteners, and welds. Additionally, students will be introduced to planetary gear trains and differential transmissions. The course emphasizes the study of mechanical components in relation to static and dynamic loads, as well as vibration phenomena.
**Prerequisites:** Machine Design 1 (020CM1ES3), Mechanical Vibrations (020VMEES2) or Vibrations (020VIBES2).

**020MLRES4 Machine Learning 4 Cr.**

This course covers machine learning (ML), a subfield of artificial intelligence focused on enabling computers to learn from examples autonomously. It addresses key research areas, including Computer Vision (CV), Natural Language Processing (NLP), and precision medicine for personalized treatments. The course provides a basic understanding of ML algorithms and hands-on ML engineering experience through Python implementations using state-of-the-art libraries such as Scikit-learn, TensorFlow, and Keras.

**020MNGES5 Management 2 Cr.**

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

**020PF1ES3 Manufacturing Processes 1 4 Cr.**

This course covers the main manufacturing processes used in the industry for different types of materials (metal, glass, plastics, rubber, composite materials, ceramics). It explains the concept of manufacturing in its large sense: the factory organization and design, the selection of processing operations and the production systems. The covered topics include the study of phase diagrams for different types of metal alloys, a global description of raw materials, and the operations used for their extraction and preparation (for metals, ceramics, polymers, and composites). In addition, the course introduces the material removal processes. It details the different operations made by a lathe, the basics of CNC machines and the G-code programming language for milling and turning processes.
**Prerequisite:** Computer Assisted Drawing (020DAMNI4 or 020DAMCI4).

**020PF2ES4 Manufacturing Processes 2 4 Cr.**

This course covers the main manufacturing processes used in the industry for different types of materials (metal, glass, plastics, rubber, composites, ceramics). It explains the techniques applied during the preparation of a product, from the fabrication of the primary parts to the finishing of the final assembled product. In addition to the "material removal processes" explained in the "Manufacturing Processes 1" course, the covered topics include: solidification processes (casting, molding), particulate processing, deformation of metals and plastics, and assembly operations (welding, over molding, threading). Also, the course describes some advanced processes and technologies such as waterjet cutting, laser cutting, layer-design, 3D printing and nanotechnologies.
**Prerequisite:** Manufacturing Processes 1 (020PF1ES3).

**020SMEES1 Mechanical Systems 6 Cr.**

This course allows students to establish the link between solid kinematics and mechanical construction. It covers the modeling and resolution of problems relating to mechanisms made of non-deformable/rigid bodies: bar-linkages and associated kinematics, kinematic diagram, parameterization, analysis of operation, determination of equations of motion (positions, speeds and accelerations), calculation of the forces applied to the parts and the generated and dissipated mechanical energies. It also introduces students to the fundamentals and principles of multi-bar connections, gears and cams. Students will model several bar systems on SolidWorks to study and visualize the movements of the mechanisms.
**Prerequisites:** Computer Assisted Drawing (020DAMCI4 or 020DAMNI4), Mechanics 2 (020MC2CI3 or 020MC2NI3).

**020VMEES2 Mechanical Vibrations 4 Cr.**

This course covers the vibrations of one-dimensional systems (1 Degree of Freedom), including undamped free oscillations, undamped forced oscillations, free damped oscillations, forced damped oscillations, stability, resonance, and systems with multiple degrees of freedom, with a focus on mechanical engineering applications and examples. Students will learn how to model a system and analyze its vibrational behavior. Linear systems with multiple degrees of freedom are solved using the mode superposition and modal analysis methods. The course also introduces non-linear systems, resolution through iterative methods, and vibration suppression techniques.
**Prerequisite:** Mechanics 2 (020MC2CI3 or 020MC2NI3).

**020MMCES4 Mechanics of Composite Materials 4 Cr.**

This course focuses on anisotropic elasticity and laminate theory, the analysis of various members of composite materials, energy methods, failure theories, and micromechanics. It also introduces materials and fabrication processes.
**Prerequisites:** Introduction to Materials Science (020ISMNI2), Strength of Materials (020RDMES1) or Strength of Materials 1 (020RM1ES2).

**020MMIES5 Mechatronics and Intelligent Machines 4 Cr.**

This course offers a comprehensive exploration of mechatronics and intelligent machines, emphasizing sensors, actuators, system modeling, computer simulation, information processing, perception, cognition, planning, control, and system design. Students will gain practical knowledge through hands-on projects and applications.
**Prerequisite:** Linear Control (020AULES2).

**020MEMES5 Micro-Electro-Mechanical Systems (MEM) 4 Cr.**

This course covers sensors, sensor noise and sensor fusion; actuators; system models and automated computer simulation; information, perception, and cognition; planning and control; architectures, design, and development.
**Prerequisite:** Electronics (020ELCES1).

**020MAMES3 Microprocessors for Mechatronic Applications 4 Cr.**

This course covers the following: Difference between microprocessors, microcontrollers and DSP – microprocessor architecture ; realization of a basic board – Microcontroller architecture (PIC 18F2520) – Implementation of ROM, RAM and DATA EEPROM memory – special registers – addressing modes – inputs/outputs – interrupts – timers – analog to digital converter – asynchronous serial port – read from program memory – comparators – watchdog – sleep mode – Low Voltage Detect – oscillator – configuration words – Design, simulation and realization of microprocessor systems.
**Prerequisite:** Electronics (020ELCES1).

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

**020MFNES5 Numerical Fluid Mechanics (CFD) 4 Cr.**

This course introduces computational fluid dynamics (CFD), a technology for solving complex fluid flow and heat transfer problems using fast and reliable calculation methods. It covers the fundamentals of the mathematical equations governing fluid flow and heat transfer while emphasizing practical applications with commercial CFD codes. The course explains how to set up, run, and interpret CFD models using various ANSYS Fluent® case studies.
**Prerequisite:** Fluid Mechanics (020MEFES1) or Fluid Mechanics 1 (020MF1ES1).

**020MENES1 Numerical Methods 4 Cr.**

This course includes 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 system of equations.
**Prerequisites:** Linear Algebra (020ALNNI2) or Algebra 1 (020AL1CI2), Differential Calculus (020CDFNI4) or Analysis 2 (020AN2CI3).

**020PLBES4 Plumbing 4 Cr.**

This course covers plumbing applicable to various building structures. Students will possess the requisite knowledge to adapt to international plumbing standards and comprehend their diverse applications. They will gain insight into French standards based on the DTU (Unifier Technical Document), American standards, including the NFPA "National Fire Protection Association" standard for firefighting. The key topics covered in this course include calculations for the dimensions of water distribution pipes, the selection of pipe types, calculations for the dimensions of evacuation pipes, sizing of booster pumps and their operational mechanisms, rainwater calculations, sizing of domestic hot water tanks, and understanding fire hoses for sprinkler systems and fire cabinets, including their operational principles.
**Prerequisite:** Hydraulics (020HYDES3).

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

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

**020PENES4 Power Generation 4 Cr.**

This course 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).

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

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

**020GPRES2 Project Management 4 Cr.**

This course explains how effective project management ensures that a project is completed on time, within budget, and with high quality. Specific techniques for accomplishing these three goals are not always so obvious.

The purposes of this course are teaching students these successful techniques, and expose them to a variety of skills to manage the budget, schedule, and quality of projects that they are or will be responsible for.

**020SFRES5 Refrigeration Systems 4 Cr.**

This course covers the following: Industrial refrigeration - The refrigeration cycle - Mollier diagram - Volumetric compression - The components of the refrigeration machine: Compressor - Heat exchangers - Refrigerant - The design of a cold room - External quantities: Thermostat - Internal quantities: Regulators - Safety equipment - Defrosting.
**Prerequisite:** HVAC 1 (020CL1ES3).

**020ERMES5 Renewable Energy for Mechanical Engineering 4 Cr.**

This course provides an overview of the latest technologies and developments in renewable energies, as well as the diversity of their applications. It explains the potentials and specificities of renewable energies in terms of electricity generation. What are these energy resources? How to capture and transform them? In what form can they be used? This course covers: The current state of renewable energies in the world and future prospects, Energy cycle on earth; Solar energy, availability conversion and applications of solar energy, thermal and photovoltaic systems; Wind power, availability, development and conversion methods; Hydroelectric power, conversion methods, types of hydraulic turbines; Biomass, sources, conversion methods; Geothermal energy, resource levels and system types. The course also addresses energy storage technologies, including electrical batteries and pumped storage systems. In addition, a socio-economic and lifecycle analysis of renewable energy systems is provided.

**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, non-linear, and adaptive controllers. Concepts of dynamic response related to vibration and motion planning are also 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 and emphasized in this course, along with their implementation using microcontrollers and/or software (MATLAB, LabVIEW, etc.).

**020SPMES4 Selection and Properties of Materials 4 Cr.**

This course explains the relation between the properties of the materials and the selection procedure during engineering applications. It starts by reviewing the relation between the structure and the properties of a material, the mechanical behavior showing the different types of deformation behavior, and the failure types including fracture, fatigue, creep, and corrosion. Then, it lists the different properties of engineering materials and details their graphical presentation. Finally, it introduces the strategy of selection following manual and computer-aided methods. It also studies the selection procedure for applications having multiple constraints and conflicting objectives and treats several examples of simple and multiple selection problems. This course discusses the importance of the material-shape relation during selection operation.
**Prerequisite:** Strength of Materials (020RDMES1) or Strength of Materials 1 (020RM1ES2).

**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).

**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).

**020RDMES1 Strength of Materials 6 Cr.**

This course covers the phenomena related to a deformable solid subjected to a system of external loads. It explores the fundamental hypotheses of beam theory and elasticity, geometric characteristics of sections, and types of stresses. Topics include generalized Hooke's law, axial stresses (mechanical, thermal stresses, and deformations), bending of beams and transverse shear (normal stresses, shear stresses, and displacements), and torsion of cylindrical members (stresses and deformations). The course also addresses bending moments and shear force diagrams, the state of stress in systems under combined loadings, and the analysis of stresses in the walls of thin-walled pressure vessels. Additionally, students will learn to calculate principal stresses, maximum in-plane shear stress, and absolute maximum shear stress. This course also introduces various static failure criteria for ductile and brittle materials. Practical applications include tensile tests on steel reinforcing bars, compressive tests on cylindrical concrete specimens, and twist tests on steel, brass, and copper specimens.
**Prerequisite:** Statics for Mechanical Engineering (020STMNI4 or 020STMCI4).

**020MOTES4 Thermal Engines 4 Cr.**

This course examines the fundamentals of the design and operation of internal combustion engines, focusing on fluid/thermal processes. The subjects covered include the analysis of the phenomena of aspiration, compression, combustion, expansion and formation of pollutants; heat transfer and friction phenomena; 2-stroke and 4-stroke engines, supercharges and performance characteristics; thermochemistry of air-fuel mixtures; social implications of motorization.
**Prerequisites:** General Chemistry (020CHGNI1 or 020CHGCI1), Thermodynamics: Laws and Applications (020TPAES1) or Thermodynamics: Principles and Phase Change (020TPPES1).

**020TPAES1 Thermodynamics: Laws and Applications 6 Cr.**

This course is designed to provide students with a comprehensive understanding of the foundational principles of thermodynamics and their practical applications in engineering systems. It integrates theoretical concepts with real-world scenarios, enabling students to apply thermodynamic principles to solve engineering problems and design efficient systems.
**Prerequisite:** Thermodynamics 1 (020TH1NI2 or 020TH1CI2).

**020TRBES3 Turbomachines 4 Cr.**

This course provides an overview of the latest technologies and developments in turbomachinery, as well as the diversity of their applications. It familiarizes students with the potential and specificities of the application of different turbomachines in the engineering world, from aviation to industrial machinery. In this course the following topics are covered: technology, operation, design and analysis of incompressible turbomachines such as centrifugal and axial flow pumps, impulse (Pelton) turbines and reaction turbines (Francis and Kaplan), as well as compressible flow turbomachines, such as: centrifugal and axial flow compressors, fans and blowers, axial and radial flow gas turbines, and steam turbines. Positive displacement pumps are also covered.

**020RBMES4 Wheeled Robots 4 Cr.**

This course provides in-depth coverage of wheeled mobile robots. It covers (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: Personal Development - Communication Skills - Job Seeking Skills - Work Behaviors.