# Electronics

1. **Course number and name:** 020ELCES1 Electronics

2. **Credits and contact hours:** 6 ECTS credits, 3x1:15 contact hours per week

3. **Name(s) of instructor(s) or course coordinator(s):** Elias Rachid and Fadia Tawil

4. **Instructional Materials:** Lecture notes, exercises, Lab assignments

   Textbooks/References:
   - Traité de l'électronique analogique et numérique (Vol.1), Paul Horowitz & Winfield Hill, Elektor,1996.
   - Principes d'électronique, Alberto P. Malvino, McGraw-Hill, 1991.
   - Electronique: composants et systèmes d'application, Thomas L. Floyd, Dunod, 2000.
   - Digital Systems, Principles and Applications, R. J. Tocci, N. S. Widmer, G. L. Moss, 11th Edition, Pearson. ISBN-13 978-0135103821.

5. **Specific course information**
   a. **Catalog description:**

   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.

   b. **Prerequisite:** Linear Electrical Systems and Networks (020SRLNI4 or 020SRLCI4).

   c. **Required** for ME students.

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**

   A student who successfully fulfills the course requirements will have demonstrated an ability to:
   - Recognize and equate the behavior of the basic electronic components such as diodes, transistors and operational amplifiers.
   - Synthesize, simulate and carry out voltage amplification based on transistors.
   - Evaluate the performance and limits of basic electronic components.
   - Understand the technical data sheets for these components.
   - Design and analyze electronic circuits based on these components in order to perform a certain function.
   - Perform the three basic logic operations.

- Write the Boolean expression for the logic gates and combinations of logic gates.
- Implement logic circuits using basic AND, OR, and NOT gates.
- Use DeMorgan's theorems to simplify logic expressions.
- Use several methods to describe the operation of logic circuits.
- Convert a logic expression into a sum-of-products expression.
- Perform the necessary steps to reduce a sum-of-products expression to its simplest form.
- Use Boolean algebra and the Karnaugh map as tools to simplify and design logic circuits.
- Explain the operation of both exclusive-OR and exclusive-NOR circuits.
- Compare the characteristics of the various CMOS series.
- Compare the advantages and disadvantages among the digital-ramp analog-to-digital converter (ADC), successive-approximation ADC, and flash ADC.
- Analyze the process by which a computer, in conjunction with an ADC, digitizes an analog signal and then reconstructs that analog signal from the digital data.

**b. PI addressed by the course:**

| PI | 1.3 | 6.1 | 6.2 | 6.3 | 6.4 |
|---|---|---|---|---|---|
| Covered | x | x | x | x | x |
| Assessed | x | x | x | x | x |

**7. Brief list of topics to be covered**

- **Part 1**
  - N and P type semiconductors – PN junction.
  - Diodes: Characteristics – Application circuits (clipping, rectification, etc.) – Zener diode (Regulation) – Light-emitting diode (Sizing).
  - Bipolar transistor: Static operation (polarization, application circuit), Dynamic operation (amplification circuit).
  - MOSFET transistor: Characteristics – Resistive operation and amplification.
  - Operational Amplifier (OA): Differential structure and differential amplifier – Basic circuit – Characteristics and limitations of static and dynamic performances, – Application circuits (logarithmic OA, instrumentation and isolation OA, active filtering, etc.).
  - Comparator: Performance characteristics and limitations – Application circuits (clock, hysteresis, peak value detector) – Digital compatibility.
- **Part 2**
  - Describing Logic Circuits: Boolean constants and variables – Truth tables – OR operation with OR gates – AND operation with AND gates – NOT operation – Describing logic circuits algebraically – Evaluating logic-circuit outputs – Implementing circuits from Boolean expressions – NOR gates and NAND gates – Boolean theorems – DeMorgan's theorems.

- Combinational Logic Circuits: Sum-of-products – Simplifying logic circuits – Algebraic simplification – Designing combinational logic circuits – Karnaugh map method – Exclusive-OR and exclusive-NOR circuits.
- Integrated-Circuit Logic Families: MOS technology – Complementary MOS logic – CMOS series characteristics – Low-voltage technology.
- Interfacing with the Analog World: Digital-to-analog conversion – D/A-converter circuitry – DAC specifications – Analog-to-digital conversion – Data acquisition – Flash ADCs.