Physical Signals

1. **Course number and name:** 020SPHNI1/020PHSNI1 Physical Signals

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

3. **Name of course coordinator:** Alain Ajami

4. **Instructional materials:** course handouts; slides; in-class problems

5. **Specific course information**
   a. **Catalog description:**
   The primary objective of this course is to ensure students develop a comprehensive grasp of 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.

   b. **Prerequisites:** None

   c. **Required/Selected Elective/Open Elective:** Required

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
   - Understand and apply the equation of the harmonic oscillator, as well as the concepts of amplitude, period, frequency, and angular frequency associated with it.
   - Grasp the notion of a signal and the principles of signal propagation.
   - Analyze and solve problems related to wave superposition and interference.
   - Define the concepts and general laws of electrokinetics in the context of linear circuits.
   - Analyze and solve problems involving resistors, coils, and capacitors in linear circuits.
   - Analyze the free response and step response of first-order RC and RL circuits.
   - Study damped oscillators by analyzing series RLC circuits and mechanical oscillators.
   - Utilize complex notation for sinusoidal signals and understand the concepts of complex impedance and admittance.
   - Apply the laws of nodes in terms of potentials and the Millman theorem in the analysis of linear circuits.
   - Recognize the main types of filters and depict the frequency behavior of a system based on the Bode diagram.

b. PI addressed by the course:

PI	1.2	1.3
Covered	x	x
Assessed	x	x

7. Brief list of topics to be covered

- Chapter 1: Harmonic Oscillator + Tutorial 1 (3 lectures)
- Chapter 2: Linear Circuits in ARQS: Definitions and General Laws of Electrokinetics - Resistor, Coil, and Capacitor - Voltage and Current Sources + Tutorial 2 (4 lectures)
- Chapter 3: First-Order Linear Circuits: Free Response, Step Response: RC Circuit - Free Response, Step Response: RL Circuit + Tutorial 3 (4 lectures)
- Chapter 4: Damped Oscillators: Series RLC Circuit and Mechanical Oscillator - Free Response, Step Response + Tutorial 4 (4 lectures)
- Chapter 5: Sinusoidal Signal and Complex Notations: Complex Notation for Sinusoidal Signal - Complex Impedances and Admittances - Nodal Laws in terms of Potentials - Millman's Theorem + Tutorial 5 (5 lectures)
- Chapter 6: Forced Electrical Oscillator and Resonance: Current Resonance - Capacitor Resonance + Tutorial 6 (4 lectures)
- Chapter 7: Linear Filtering: Linear Filter - Transfer Function and Bode Diagram - First-Order Filters - Second-Order Filter + Tutorial 7 (4 lectures)
- Chapter 8 : Signal Propagation : Signal Notion - Signal Propagation + Tutorial 8 (4 lectures)
- Chapter 9: Wave Superposition and Interference: Standing Waves - Wave Interference + Tutorial 9 (4 lectures)