Linear Electrical Systems and Networks

1. **Course number and name:** 020SRLNI4 Linear Electrical Systems and Networks

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

3. **Name(s) of instructor(s) or course coordinator(s):** Alain Ajami, Alfred Hayek, Adnan Naja

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

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

   b. **Prerequisites:** 020SPHNI1 Physical signals

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

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
   - Analyze a linear electric circuit
   - Master the use of voltage and current sources: extinction and establishment
   - Recognize the general theorems: superposition, substitution, Thévnin, Norton, and Millemann.
   - Calculate the different characteristics: voltage, current, power from general theorems
   - Find the linear circuit transfer function and deduce its performance
   - Master the use of Bode, Niquist and Black diagrams
   - Studying the response of a linear electrical system to any given deterministic input by establishing the differential equation and applying the Laplace transform

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

PI	1.3	6.2	7.1
Covered	x	x	x
Assessed	x	x	

7. Brief list of topics to be covered

- Signals and systems: Concept, definitions, random, deterministic, continuous and discrete signals. Quantities associated with a signal: instantaneous quantities, average value, average power and energy. Usual signals: periodic, alternate, rung, Dirac. Concept of System: Definition, examples of linear systems, natures and properties of systems (1 lecture)
- Linear systems- Response to a given excitation- Transfer function- Stability; Laplace transform, Definitions, Properties, Application to the resolution of linear differential equations with constant coefficients. Physical properties of response (6 lectures)
- Linear electrical networks: General topological definitions, dipole, network (branches, links, knot). Properties of electrical networks: Conventions of electricians. Kirchoff Laws: Electrical elementary dipoles, Sources (current, voltage) independent and related extinction of a source, passive dipoles (resistor, capacitor, coil) mutual inductance. Association of dipoles: Series, parallel, principle of duality. Aspect of the dipoles: Receiver and generator (3 lectures)
- General Theorems: Principle of superposition, substitution principle, Thevenin Voltage divider, Kenelly, Millmann Theorems, Theorems resulting from the Norton duality principle, current divider, substitution - Millman (6 lectures)
- Permanent sinusoidal regime: Interest of steady state regime. Complex transformation, Equation of Linear Electrical Networks, complex impedance and admittance, energy considerations in sinusoidal regime, complex power, Boucherot theorem (6 lectures)
- Diagrams: Notion of transmittance (transfer function), Bode diagram, Black diagram, Nyquist diagram (2 lectures)
- Lab session (10 lectures)