Linear Control

1. **Course number and name:** 020AULES2 Linear Control

2. **Credits and contact hours:** 6 ECTS credits, 3x1:15 contact hours per week + 12 lab hours.

3. **Instructor's or course coordinator's name:** Flavia Khatounian and Jean Sawma

4. **Instructional Materials:** PowerPoint presentation, Exercises, Mini-project instructions, Lab experiments instructions

   Textbooks/References:
   - J. Ch. GILLE, P. DECAULNE et M. PELEGRIN, "*Théorie et calcul des asservissements linéaires*", Éditions DUNOD, France, 1987.
   - J. Ch. GILLE, P. DECAULNE et M. PELEGRIN, "*Dynamique de la commande linéaire*", Éditions DUNOD, France., 1993.
   - J. Ch. GILLE, P. DECAULNE et M. PELEGRIN, "*Les organes des systèmes asservis*", Éditions DUNOD, France, 1965.
   - Patrick PROUVOST, "*Automatique – Contrôle et régulation*", Éditions DUNOD, France, 2010.
   - Sandrine LEBALLOIS, "*Automatique – Systèmes linéaires et continus*", Editions DUNOD, France, 2006.
   - Katsuhiko OGATA, "*Modern Control Engineering*", 5th edition, Prentice Hall, 2010.

5. **Specific course information**
   a. **Catalog description:**
      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 1^{st} and 2^{nd} 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. 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.

   b. **Co-requisite:** Analog electronics (020ELAES1) or **Prerequisite:** Electronics (020ELCES1).

   c. **Required** for EE and ME students.

6. **Educational objectives for the course:**
    a. **Specific outcomes of instruction:**
        - Identify and analyze linear systems (transient and steady state response analysis of 1st and 2nd order linear systems, frequency-response analysis using Bode, Nyquist and Nichols diagrams, etc.).
        - Analyze closed-loop control systems performances (stability analysis, precision, time response, peak response, etc.).
        - Propose and design linear control systems using different types of controllers using frequency-response methods, analytical calculations, and experimental techniques.
        - Use Matlab and Matlab/Simulink to analyze, test, design and validate linear control systems.

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

PI	1.1	1.2	1.3	6.1	6.2	6.3	6.4
Covered	x	x	x	x	x	x	x
Assessed				x	x	x	x
Give feedback				x	x	x	x

7. **Brief list of topics to be covered**
    - Course introduction (1 Lecture).
    - Analysis of 1st and 2nd order linear systems: definition, transient and steady-state response, frequency-response using Bode, Nyquist and Nichols diagrams, examples (5 Lectures).
    - Introduction to closed-loop versus open-loop control systems: bloc diagrams, transfer functions, feedback signal, reference, etc. (3 Lectures).
    - Stability analysis (3 Lectures).
    - Precision analysis (2 Lectures).
    - Introduction to MATLAB and MATLAB/Simulink (2 Lectures).
    - Control of linear systems using different types of controllers (3 Lectures).
    - Analytical design of PID controllers: Determination of the proportional, integral and derivative parameters of a PID controller for 1st and 2nd order linear systems (5 Lectures).
    - Control of special cases of linear systems using zero-pole compensation, derivative feedback, etc. (2 Lectures).
    - Exercises, problem solving and case studies (10 Lectures).
    - Workshops using Matlab/Simulink (12 lab hours)
    - Experimental identification and control of a linear system (9 lab hours)