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 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. 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	Х	Х	Х	Х	х	Х	Х
Assessed				Х	х	Х	Х

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)