Course Syllabus

1. Course number and name: **020AULES2 – Linear control**

2. Credits and contact hours: **3 credits, 44 contact hours + 21 lab hours**

3. Instructor's or course coordinator's name: **Flavia KHATOUNIAN**

4. Text book
   a. J. Ch. GILLE, P. DECAULNE et M. PELEGRIN, "*Théorie et calcul des asservissements linéaires*", Éditions DUNOD, France, 1987.
   b. J. Ch. GILLE, P. DECAULNE et M. PELEGRIN, "*Dynamique de la commande linéaire*", Éditions DUNOD, France., 1993
   c. J. Ch. GILLE, P. DECAULNE et M. PELEGRIN, "*Les organes des systèmes asservis*", Éditions DUNOD, France, 1965.
   d. Patrick PROUVOST, "*Automatique – Contrôle et régulation*", Éditions DUNOD, France, 2010.
   e. Sandrine LEBALLOIS, "*Automatique – Systèmes linéaires et continus*", Editions DUNOD, France, 2006.
   f. Katsuhiko OGATA, "*Modern Control Engineering*", 5th edition, Prentice Hall, 2010
   g. other supplemental materials: PowerPoint presentation, Exercises, Mini-project instructions, Lab experiments instructions

5. Specific course information
   a. brief description of the content of the course (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 based on Routh's stability criterion as well as Hurwitz stability criterion. The second part covers the analysis and design of linear control systems using different types of PID controllers and lead/lag compensation techniques. Design of such controllers is presented using frequency-response methods, analytical calculations and experimental techniques such as Ziegler–Nichols tuning rules. 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. prerequisites or co-requisites: **020SRLNI4 or 020SRLCI4 – Linear Electrical Systems and Networks**

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

6. Specific goals 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 PID controllers and lead/lag compensation techniques using frequency-response methods, analytical calculations and experimental techniques such as Ziegler–Nichols tuning rules.
- Use Matlab and Matlab/Simulink to analyze, test, design and validate linear control systems.

    b. KPIs addressed by the course

KPI	**a1**	**a2**	**b1**	**b2**	**b3**	**k3**
Covered		x	x	x	x	x
Assessed	x	x	x	x	x	x
Give Feedback						

7. Brief list of topics to be covered and approximate lecture hours:

- Course introduction (1.25 hours)
- Analysis of 1st and 2nd order linear systems: definition, transient and steady-state response, frequency-response using Bode, Nyquist and Nichols diagrams, examples (6.25 hours)
- Introduction to closed-loop versus open-loop control systems: bloc diagrams, transfer functions, feedback signal, reference, etc. (3.75 hours)
- Stability analysis based on Routh's stability criterion as well as Hurwitz stability criterion (3.75 hours)
- Precision analysis, types of steady-state error: position, speed, acceleration (2.5 hours)
- Introduction to Matlab and Matlab/Simulink (2.5 hours)
- Control of linear systems using different types of PID controllers (P, PI, PD and PID) and lead/lag compensation techniques (3.75 hours)
- 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 hours).
- Control of special cases of linear systems using zero-pole compensation, derivative feedback, etc. (2.5 hours)
- Exercises, problem solving and case studies (12.5 hours)
- Workshops using Matlab/Simulink (12 lab hours)
- Experimental identification and control of a linear system (9 lab hours)