Master's Department of Engineering Sciences

Name of the unit: State-space representation for automatic control

Lecturer: Mahdi Khoramshahi (mahdi.khoramshahi@isir.upmc.fr)
Course code: UM4RBR10-Etat
Student workload: 12h of lectures, 8h of tutorial sessions, 4h of lab sessions@
Credits: 3 ECTS

Specialization tracks:				
	- **E3A** :	☐ CIMES	☐ Syscom	☐ IPS
	- **AR** :	☒ ROBOT	☐ SI	☐ MeDH
	- **MECA** :	☐ MS2	☐ MF2A	☐ CompMech
		☐ ACOU	☐ EE	☐ EE APP

Semester offered: ☒ S1 ☐ S2 ☐ S3 ☐ S4
Language of instruction: ☒ French ☐ English
Targeted audience: ☒ Engineering Sciences students ☐ Other (specify):
Localization : ☒ PMC Campus ☐ Other (specify):

Course Overview

This UE provides the basis for linear automation in state representation. Starting from a general nonlinear control system, we first introduce the notion of tangent linearized system. From there, the concepts of controllability, observability, stability are presented. The last part of the course focuses on the synthesis of controllers and linear observers.
Keywords: linear control system, tangent linearized system, commandability, observability, stability, controller synthesis by pole placement, LQR control, observer synthesis, transfer function realization.

Prerequisites

Students should have previously acquired the following prerequisites to follow this course:

- Linear algebra (determinant and rank of a matrix)
- Differential calculus (Jacobian matrix, limited expansion)
- Ffrequency domain automatic control (Laplace transform, transfer function, PID control)

Intended Learning Outcomes

By the end of this course, students will be able to:

1. Determine the equilibrium points of a non-linear control system
2. Calculating a tangent linearized system
3. Determine whether a linear control system is controllable or not
4. Determine whether a linear control system is observable or not
5. Determining the Asymptotic Stability Properties of a Linear System
6. Synthesize a status feedback order by pole placement
7. Summarize a state observer by pole placement
8. Know the conditions of use of the LQR command
9. Moving from a state representation to a frequency representation and vice versa
10. Use matlab tools to synthesize state feedback control laws and observers
11. Implementing Control Schematics with Simulink

Indicative Teaching Sequence and Methods

Week	C/TD/TP*	Content	Preparation	Learn. outc.
S1	C1 (2h)	Mathematical reminders, definition of a linear system, notion of tangent linearized system		AAV1, AAV2
S2	C2 (2h)	Introduction of the notions of controllability, observability		AAV3, AAV4
S3	TD1 (2h)	Covers C1 and C2		
S4	C3 (2h)	Lyapunov stability, controller synthesis by pole placement		AAV5, AAV6
S5	C4 (2h)	Observer Synthesis, Separation Principle, Gain Adjustment		AAV6, AAV7
S6	TD2 (2h)	Focuses on C1-C3		
S7	C5 (2h)	LQR Control, Matlab Tools, Command and Saturation		AAV8
S8	TD3 (2h)	Focuses on C4-C5		
S9	C6 (2h)	Relationships between state representation and frequency representation		AAV9
S10	TD4 (2h)	Applies to C5-C6		
S11	TP (4h)		Preparation of lab session	Tous

* C/TD/TP respectively corresponds to lectures, tutorials and lab sessions.

Indicative Assessment of Intended Learning Outcomes (1st session)

Week	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
S13	Individual	In-person	Written	AAV1-AAV9	70 %
S13	Individual	In-person	Written	AAV10-AAV11	30 %

2nde session of exam

Session	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
2	Individual	In-person	Written	AAV3-AVV8	70 %
1	Individual	In-person	Written	AAV10-AAV11	30 %

Bibliographic references

- B. d'Andréa-Novel, M. Cohen de Lara, "Commande linéaire des systèmes dynamiques", Presse des Mines, 2000.
- Y. Granjon, "Automatique: systèmes linéaires, non linéaires, à temps continu, à temps discret, représentation d'états", Dunod, 2021.

Date of generation of this unit description: January 14, 2026