

# UE Modeling and learning dynamics



Niveau d'étude  
Bac +5



ECTS  
6 crédits



Composante  
UFR Physique,  
Ingénierie,  
Terre,  
Environnement,  
Mécanique  
(PhITEM)



Période de  
l'année  
Automne (sept.  
à dec./janv.)

## Diplômes intégrant cet élément

- Master Electronique, énergie électrique, automatique

- › Langue(s) d'enseignement: Anglais
- › Ouvert aux étudiants en échange: Oui
- › Code d'export Apogée: PAX9MIAP

## Présentation

### Description

This course offers a comprehensive and modern introduction to **modeling, simulation, and system identification** for dynamical systems, with a strong emphasis on methods tailored for control, supervision, and optimization. Students learn how to build **control-oriented models** that capture the essential multi-physics behavior of complex systems while remaining computationally efficient—an indispensable skill for real-time control, diagnosis, and iterative optimization. The course bridges physical modeling principles, energy-consistent multi-domain formalisms (such as **bond graphs**), numerical simulation techniques, and the fundamentals of **system identification**, highlighting their deep connections with today's machine-learning approaches for dynamical systems. Through a combination of theory, hands-on computational tools, and application-driven labs, students gain the ability to design models from first principles, integrate data-driven insights, validate and refine model structures, and deploy online estimation algorithms for intelligent system monitoring and control.

The modern foundations of **data-driven model learning** are introduced to students, empowering them to extract meaningful structure from real-world **time-series data** using the essential tools of linear algebra, optimization, and statistics. Through an intuitive and application-oriented approach, the class blends theory with hands-on work on real datasets, guiding students from basic concepts of time-series decomposition and Singular Spectrum Analysis to trend and seasonality modeling, residual analysis, and AR/ARMA forecasting. Emphasizing both mathematical insight and practical relevance, the course demystifies key ideas such as SVD and least-squares estimation, showing how these components fit together to produce powerful forecasting models. Designed for engineers seeking actionable, interpretable, and computationally efficient techniques, this course prepares students to build robust data-driven models and tackle real-world challenges in prediction, analysis, and system identification.

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## Heures d'enseignement

|      |                                   |     |
|------|-----------------------------------|-----|
| CMTD | Cours magistral - Travaux dirigés | 33h |
| TP   | TP                                | 36h |

**Période :** Semestre 9

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## Bibliographie

Reference textbooks :

- L. Ljung and T. Glad, "Modeling of Dynamic Systems", Prentice Hall PTR, 1994.
- S. Stramigioli, "Modeling and IPC Control of Interactive Mechanical Systems: A Coordinate-free Approach", Springer, LNCIS 266, 2001.
- L. Ljung, "System Identification: Theory for the User", 2nd Edition, Information and System Sciences, (Upper Saddle River, NJ: PTR Prentice Hall), 1999.
- G. Mercère. Data Driven Model Learning for Engineers. Springer Nature Switzerland, 2023.

## Infos pratiques

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### Contacts

Responsable pédagogique

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## Lieu(x) ville

➤ Grenoble

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## Campus

➤ Grenoble - Polygone scientifique