Course unit English denomination	Kalman Filter and State Space Models
Teacher in charge (if defined)	Siem Jan Koopman
Teaching Hours	9
Number of ECTS credits allocated	1
Course period	06/2025-07/2025
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (100% minimum of presence, apart from exceptional absences that must be justify in advance) ☐ No

Course unit contents	- Introduction
	- Time Series Models
	  - Local Level Model
	  - Unobserved Component Time Series Models
	  - Multivariate Extension, incl. Dynamic Factor Models
	- State Space Methods
	  - Kalman Filter
	  - Observation Weights
	  - Log likelihood Evaluation and Parameter Estimation
	  - Diagnostic Checking
	  - Smoothing
	  - Missing Values and Forecasting
	  - Usage of Principal Components
	- Nonlinear non-Gaussian Extensions
	  - Extended Kalman filter
	  - Dynamic models for discrete data
	  - Stochastic Volatility
	- Conclusion and Discussion

Learning goals	Students will understand the principles of state space models and Kalman Filters, including the necessary mathematical foundations. They will learn to model dynamic systems, design and implement standard and extended Kalman Filters, but also particle filters, and evaluate their performance through diagnostic error analysis. The course will cover real-world applications and software development for implementation.
Teaching methods	• Lectures • Laboratories
Course on transversal, interdisciplinary,	☐ Yes ☐ No

transdisciplinary skills	
Available for PhD students from other courses	☒ Yes ☐ No Students from other PhD courses may be admitted subject to CV evaluation and until the maximum number of students has been reached
Prerequisites	An intermedaite level of statistical theory, time series models and matrix algebra are required for this course.
Examination methods (in applicable)	None
Suggested readings	• Course material available from the instructor • Commandeur, J. J. F. & Koopman, S. J. (2007). An Introduction to State Space Time Series Analysis. Oxford University Press • Durbin, J. & Koopman, S. J. (2012). Time Series Analysis by State Space Methods. Oxford University Press
Additional information	