



Study blocks for the Econo-Mathematics Master

- **Block A:** Prerequisites (for admission to the Master programme)

Required topics

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|-----------------------------------|---------|
| Basic knowledge in calculus | 18 ECTS |
| Linear Algebra | 6 ECTS |
| Some basics in numerical analysis | 6 ECTS |
| Programming skills | 6 ECTS |
| Basics in statistics | 6 ECTS |
| Total amount of courses | 42 ECTS |

- **Block B:** At least 2 out of 6 of the listed topics are required for admission.
The remaining topics are required during the Master study.

Required topics:

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|---|------------------|
| Transforms, linear systems, basics in ODE | 6 ECTS |
| Basics and numerics in PDE | 6 ECTS |
| Stochastic processes | 6 ECTS |
| Optimization | 6 ECTS |
| Finances and Economics | 6 ECTS |
| Quantitative Finances and Economics | 6 ECTS |
| Total amount of courses | at least 36 ECTS |

- **Block C:** Elective courses in the field of industrial econo-mathematics.
Every student can choose among offered specialization courses at her/his home university or at an ECMI partner university.

Requirements:

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| Total amount of courses | at least 48 ECTS |
| among these courses: | |
| Mathematical courses | at least 36 ECTS |
| Quantitative Finances and Economics | at least 6 ECTS |

Modelling activities

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| International ECMI modelling week | 3 ECTS |
| Further modelling activities (European Summer School, project, study groups, internships etc.) | 6 ECTS |



Master thesis The thesis should be related to a real industrial problem. It could preferably be carried out in an interdisciplinary environment involving participants from industry. 30 ECTS

Details on the topics in Block B for the Econo-Mathematics Master

Transforms, linear systems, basics in ODE: (examples of topics)

- Fourier series, Fourier and Laplace transforms
- Systems of linear differential equations (state space theory, diagonalization, stability)
- Quadratic forms
- Input-output relations (transfer function, impulse response)

Basics and numerics in PDE: (examples of topics)

- First order PDE
- Linear second order PDE
- Series expansions
- Fourier's method
- Wave propagation
- Functions spaces and norms
- Distributions
- Methods for time integration
- Finite difference methods
- Explicit and implicit Runge-Kutta

Stochastic processes: (examples of topics)

- Models for stochastic dependence.
- Concepts of description of stationary stochastic processes in the time domain: expectation, covariance, and cross-covariance functions.
- Concepts of description of stationary stochastic processes in the frequency domain: effect spectrum, cross spectrum.
- Special processes: Gaussian process, Wiener process, white noise, Gaussian fields in time and space.
- Stochastic processes in linear filters: relationships between in- and out-signals, auto regression and moving average (AR, MA, ARMA), derivation and integration of stochastic processes.
- The basics in statistical signal processing: estimation of expectations, covariance function, and spectrum.
- Application of linear filters: frequency analysis and optimal filters.

Optimization: (examples of topics)

- Quadratic forms and matrix factorisation.
- Convexity.
- The theory of optimisation with and without constraints: Lagrange functions, Kuhn-Tucker theory, Duality.
- Methods of optimisation without constraints: line search, steepest descent, Newton methods, conjugate directions, non-linear least squares optimisation.
- Methods of optimisation with constraints: linear optimisation, the simplex method, quadratic programming, penalty and barrier methods.

Finances and Economics: (examples of topics, microeconomic theory)

- The theory of supply, demand and equilibrium on a market



- Consumer theory, i.e. the theory of the economic behaviour and decision-making of individuals.
- The theory of production and deals with the actions of a firm under various market structures (perfect competition, monopoly, oligopoly and monopolistic competition).
- Market failure externalities and public goods. Here, it is analysed how society deals with the production and distribution of goods where the market cannot achieve the optimal solution on its own.

Quantitative Finances and Economics: (examples of topics, microeconomic theory)

- The theory of individual choice; choice under uncertainty is treated separately.
- Application on financial and insurance problems.
- The dual approach to production theory is defined and applied to efficiency analysis of economic units.
- Game theoretic solution methods are defined and used to analyse firms' strategic quantity and price setting problems on markets with a small number of agents.
- Introduction to financial economics; among other things the theory of portfolio choice and equilibrium pricing of financial assets are discussed along with arbitrage free pricing of derivatives.

Examples for courses in block C for the Econo-Math. Master

at Lund University

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| Non-Linear Time Series Analysis | AMS 37M10, 91B84 |
| Financial Statistics | AMS 91B84 |
| Predictive Control | AMS 93-XX |
| Market-driven Systems | AMS 93-XX, 34Hxx |
| Microeconomics – Theory for Individual Choice and Game Theory | AMS 91-XX |

at the Autonomous University of Barcelona

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| For Stochastic processes: | AMS 60G15, 60G44, 60G46, 60J10, 60J60, 62M10 |
| for economics: | 91B16, 91B24, 91B38, 91B42, 91B50, 91B64 |
| Micro economics and Macroeconomics | 91B64 |
| For quantitative finances and economics: | 91B28, 91B30, 91B70, 62M10, 91B82, 91B84 |
| Finance and econometrics | 91B84 |