

Content

| Course Code | Course Name | Semester | Theory | Practice | Lab | Credit | ECTS |
|-------------|--|----------|--------|----------|-----|--------|------|
| MATH 601 | Mathematical Foundations of Machine Learning | 1 | 3 | 0 | 0 | 3 | 7 |

| | |
|------------------------|--|
| Prerequisites | |
| Admission Requirements | |

| | |
|-------------------------|---|
| Language of Instruction | English |
| Course Type | Elective |
| Course Level | Doctoral Degree |
| Objective | To teach students machine learning principles and equip them with focused tools to apply data analysis, manifestations, regression, clustering, and dimensionality reduction techniques. |
| Content | This course covers the principles of machine learning, focusing particularly on its mathematical foundations. Students will learn fundamental machine learning concepts such as data analysis, regression, classification, clustering, and dimensionality reduction techniques, and will use mathematical tools to apply them. |
| References | Learning Theory from First Principles, Francis Bach Deep Learning, Ian Goodfellow, Yoshua Bengio and Aaron Courville High-Dimensional Probability, Vershynin Convex Optimization, Boyd ve Vandenberghe Elements of Information Theory, Cover ve Thomas Understanding Machine Learning, Shalev-Shwartz ve Ben-David Pattern Recognition and Machine Learning, Christopher Bishop, Machine Learning: A Probabilistic Perspective, Kevin Murphy |

Theory Topics

| Week | Weekly Contents |
|------|---|
| 1 | Linear Algebra Basics |
| 2 | Spectral Theory |
| 3 | Singular Value Decomposition |
| 4 | Positive Matrices and Perron--Frobenius |
| 5 | Calculus Refresher |
| 6 | Convex Sets and Functions |
| 7 | Convex Optimization |
| 8 | Nonconvex Optimization |
| 9 | Probability Theory Foundations |
| 10 | Concentration Inequalities |
| 11 | Advanced Probability for Machine Learning |
| 12 | Statistical Estimation |
| 13 | High-Dimensional Statistics |
| 14 | Information Theory Essentials |