

# SYLLABUS

## 1. Information about the program

1.1 Higher education institution	Universitatea Politehnică Timișoara
1.2 Faculty <sup>1</sup> / Department <sup>2</sup>	ELECTRONICS, TELECOMMUNICATIONS AND INFORMATION TECHNOLOGIES / Applied Electronics Department
1.3 Field of study (name/code <sup>3</sup> )	Electronics, Telecommunications and Information Technologies Engineering /20/20/10
1.4 Study cycle	Master
1.5 Study program (name/code/qualification)	AUTOMOTIVE ELECTRONIC SYSTEMS/ 20/20/10 / 2152

## 2. Information about discipline

2.1a Name of discipline/The educational classe <sup>4</sup>	Machine Learning / DF						
2.1b Name of discipline in Romanian	Sisteme de Învățare Automată						
2.2 Coordinator (holder) of course activities	Lect. Dr. Eng. Marina Adriana Mercioni						
2.3 Coordinator (holder) of applied activities <sup>5</sup>	Lect. Dr. Eng. Marina Adriana Mercioni						
2.4 Year of study <sup>6</sup>	1	2.5 Semester	2	2.6 Type of evaluation	E	2.7 Regime of discipline <sup>7</sup>	DOP

## 3. Total estimated time (direct activities (fully assisted), partially assisted activities and unassisted activities<sup>8</sup>)

3.1 Number of hours fully assisted/week	4 ,of which:	course	2	seminar/laboratory/project	1
3.1* Total number of hours fully assisted/sem.	42 ,of which:	course	28	seminar/laboratory/project	14
3.2 Number of on-line hours fully assisted/sem	,of which:	course		seminar/laboratory/project	
3.3 Number of hours partially assisted/week	,of which:	project, research		training	hours designing M.A. dissertation
3.3* Number of hours partially assisted/ semester	,of which:	project of research		training	hours designing M.A. dissertation
3.4 Number of hours of unassisted activities/ week	7.71 ,of which:	Additional documentation in the library, on specialized electronic platforms, and on the field			2.5
		Study using a manual, course materials, bibliography and lecture notes			2.5
		Preparation of seminars/ laboratories, homework, assignments, portfolios, and essays			2.7 1
3.4* Total number of hours of unassisted activities/ semester	108 ,of which:	Additional documentation in the library, on specialized electronic platforms, and on the field			35
		Study using a manual, course materials, bibliography and lecture notes			35
		Preparation of seminars/ laboratories, homework, assignments, portfolios, and essays			38
3.5 Total hrs./week <sup>9</sup>	11.71				
3.5* Total hrs./semester	150				
3.6 No. of credits	6				

## 4. Prerequisites (where applicable)

4.1 Curriculum	•
4.2 Learning outcomes	•

## 5. Conditions (where applicable)

5.1 of the course	• The classroom is equipped with a video projector and a smart whiteboard
5.2 to conduct practical activities	In accordance with the laboratory sheet •

## 6. Learning outcomes acquired through this discipline

Knowledge	<ul style="list-style-type: none"> <li>• C4. The student/graduate understands techniques for preparing design sketches and technical documentation, integrated into the approval and validation processes of engineering projects.</li> <li>• C5. The student/graduate explains the principles and technologies of automation as applied to industrial processes.</li> <li>• C15. The student/graduate is familiar with testing procedures and standards applicable to power electronic systems, as well as engineering solutions for performance optimization.</li> <li>• C17. The student/graduate explains methods and techniques for designing sensors and integrated sensor systems within complex products.</li> <li>•</li> </ul>
Skills	<ul style="list-style-type: none"> <li>• A1. The student/graduate approves engineering projects, applying quality standards, technical regulations, and sustainability criteria.</li> <li>• A4. The student/graduate prepares technical reports and project documentation, integrating testing data, comparative analyses, and implementation recommendations.</li> <li>• A5. The student/graduate drafts technical reports and project documentation in compliance with engineering standards.</li> <li>• A7. The student/graduate analyzes and interprets experimental data using statistical techniques and engineering methods.</li> <li>• A8. The student/graduate uses dedicated software for data analysis, interpreting information derived from industrial processes.</li> <li>• A14. The student/graduate integrates automation technologies into manufacturing and industrial monitoring processes.</li> <li>• A15. The student/graduate analyzes and interprets experimental and operational data to optimize industrial equipment performance.</li> <li>•</li> </ul>
Responsibility and autonomy	<ul style="list-style-type: none"> <li>• RA1. The student/graduate assumes responsibility for coordinating and approving engineering projects, assessing the technical, economic, and environmental impact of proposed solutions.</li> <li>• RA2. The student/graduate demonstrates autonomy in leading scientific research and making complex engineering decisions, coordinating multidisciplinary technical teams.</li> <li>• RA4. The student/graduate promotes innovation and lifelong learning, integrating scientific and technological progress into research and development activities.</li> <li>• RA5. The student/graduate assumes responsibility for preparing and communicating technical reports to stakeholders.</li> <li>• RA6. The student/graduate engages in lifelong learning, continuously updating competences in line with scientific and technological progress.</li> <li>• RA9. The student/graduate coordinates multidisciplinary teams for the design, implementation, and testing of monitoring systems.</li> <li>• RA11. The student/graduate assumes responsibility for the accuracy and quality of analyses and results obtained in microsystems research.</li> <li>• RA13. The student/graduate coordinates and contributes to research and development teams, fostering collaboration and knowledge exchange.</li> <li>•</li> </ul>

## 7. Objectives of the discipline (based on the grid of learning outcomes acquired)

<ul style="list-style-type: none"> <li>• Offering graduates a specialization dedicated to deepening their knowledge of Electronic Systems for the Automotive Industry.</li> <li>• Providing skills related to the analysis, modeling, design, and implementation of complex automotive systems.</li> <li>• Developing research skills for graduates of the bachelor's degree program in automotive electronics.</li> <li>•</li> </ul>
---

## 8. Content

8.1 Course	Number of hours	Of which online	Teaching methods
Course 1. Introduction. Data Preprocessing	2		Whiteboard, Virtual Campus, Videoprojector
Course 2. Regression and Generalized Linear Models	2		
Course 3. Classification and Advanced Ensemble Methods	2		

Course 4. Clustering	2		
Course 5. Association rule learning	2		
Course 6. Reinforcement learning	2		
Course 7. Natural Language Processing (Transformers, LLMs)	2		
Course 8. Deep Learning	2		
Course 9. Dimensionality reduction	2		
Course 10. Model selection and boosting	2		
Course 11. Transforming Industries with Machine Learning Applications	2		
Course 12. Explainable AI and Model Interpretability	2		
Course 13. Track, evaluate, and optimize ML applications MLflow	2		
Course 14: Capstone Project: End-to-end ML pipeline + research papers proposals and innovations to publish in local (DrETC) and international conferences/journals	2		
Bibliography <sup>10</sup> teaching materials on Virtual Campus Murphy, K. P. Probabilistic Machine Learning: An Introduction, 2022. Geron, A. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (3rd Edition), 2022. Russell, S., & Norvig, P. Artificial Intelligence: A Modern Approach (4th Edition), 2021. Alpaydin, E. Introduction to Machine Learning (4th Edition), 2020. Goodfellow, I., Bengio, Y., & Courville, A. Deep Learning, 2016.			
<b>8.2 Applied activities<sup>11</sup></b>	<b>Number of hours</b>	<b>Of which online</b>	<b>Teaching methods</b>
1. Data exploration and preprocessing. Cleaning, normalization, encoding and anomaly detection in real datasets	2		
2. Implementation of linear and logistic regression models. Performance analysis, regularization (L1/L2) and generalized linear models (GLM)	2		
3. Advanced classification using ensemble methods. Training and comparing Random Forest, Gradient Boosting and XGBoost algorithms	2		
4. Unassisted clustering. Applying K-Means, DBSCAN and hierarchical algorithms on complex datasets	2		
5. Association rule discovery. Using Apriori and FP-Growth algorithms to extract frequent patterns	2		
6. Modeling an RL agent in discrete environments. Implementation of the Q-Learning algorithm and analysis of optimal strategies	2		
7. Natural Language Processing with Transformer Models. Training and Using an LLM for Classification, Summarization, and Text Generation	2		
8. Building a deep learning model. Implementing a feedforward neural network or CNN using PyTorch/TensorFlow	2		
9. Data dimensionality reduction. Applying PCA, t-SNE and UMAP for visualization and optimization	12		
10. Model selection and amplification. Hyper-optimization techniques (Grid Search, Random Search, BayesOpt) and cross-validation			
11. Case study: Transforming an industrial domain through machine learning. Full implementation on real data (finance, healthcare, retail, etc.)			

12. Explainable AI. Applying interpretation methods such as LIME, SHAP and feature analysis for model transparency 13. Monitoring and optimizing ML experiments with MLflow. Model tracking, versioning and training metrics management 14. Capstone project: Building a complete ML pipeline + developing a research proposal eligible for local and international conferences/journals (DrETC, IEEE, etc.)			
	Bibliography <sup>12</sup> teaching materials on Virtual Campus Murphy, K. P. Probabilistic Machine Learning: An Introduction, 2022. Geron, A. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (3rd Edition), 2022. Russell, S., & Norvig, P. Artificial Intelligence: A Modern Approach (4th Edition), 2021. Alpaydin, E. Introduction to Machine Learning (4th Edition), 2020. Goodfellow, I., Bengio, Y., & Courville, A. Deep Learning, 2016.		

## 9. Evaluation

Type of activity	9.1 Evaluation criteria <sup>13</sup>	9.2 Evaluation methods	9.3 Share of the final grade
9.4 Course	Knowledge of AI architectures, algorithms and principles	Written exam	0.50
9.5 Applied activities	<b>S:</b>		
	<b>L:</b> The degree of understanding of the various algorithms introduced, along with the capability to implement them using the Python programming language	Oral exam	0.10
	<b>P:</b> Implementing a specific artificial intelligence topic	Oral exam	0.40
	<b>Pr:</b>		
	<b>Tc-R<sup>14</sup>:</b>		
<b>9.6</b> Minimum performance standard (minimum amount of knowledge necessary to pass the discipline and the way in which this knowledge is verified <sup>15</sup>			
<ul style="list-style-type: none"> <li>Broad knowledge of AI architectures, algorithms and principles, verified by written exam, with a minimum score of 5.</li> </ul>			

### Date of completion

24.09.2025

### Course coordinator (signature)

Lect. Dr. Eng. Marina Adriana Mercioni

### Coordinator of applied activities (signature)

Lect. Dr. Eng. Marina Adriana Mercioni

### Head of Department (signature)

Assoc. Prof. Dr. Eng. Mircea Babaita

### Date of approval in the Faculty Council <sup>16</sup>

7.10.2025

### Dean (signature)

Dr.habil.eng. Catalin Daniel Căleanu,  
Professor