SYLLABUS

1. Data about the program of study

1.1 Institution	The Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Computer Science
1.4 Field of study	Computer Science and Information Technology
1.5 Cycle of study	Master
1.6 Program of study / Qualification	Data Science / Master
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Time Series Analysis***			Subject code	**8.20**
2.2 Course responsible / lecturer	Lect.dr.eng. Raluca-Laura Portase - raluca.portase@cs.utcluj.ro				
2.3 Teachers in charge of seminars / Laboratory / project	Lect.dr.eng.- Raluca-Laura Portase - raluca.portase@cs.utcluj.ro				
2.4 Year of study	1	2.5 Semester	2	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	E
2.7 Subject category	Formative category: DA – advanced, DS – speciality, DC – complementary				DA
	Optionality: DI – imposed, DO – optional (alternative), DF – optional (free choice)				DO

3. Estimated total time

3.1 Number of hours per week	3	of which:	Course	1	Seminars	1	Laboratory	1	Project	-
3.2 Number of hours per semester	42	of which:	Course	14	Seminars	14	Laboratory	14	Project	-
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										20
(b) Supplementary study in the library, online and in the field										10
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										20
(d) Tutoring										5
(e) Exams and tests										3
(f) Other activities:										

3.4 Total hours of individual study (suma (3.3(a)…3.3(f)))	58
3.5 Total hours per semester (3.2+3.4)	100
3.6 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 Curriculum	Machine Learning
4.2 Competence	Operating with fundamental computer science concepts; Familiarity with linear algebra; Python programming language;

5. Requirements (where appropriate)

5.1. For the course	MS Teams Platform, Moodle platform. Attending min 50% of the lectures and an average grade of min 5 at the applications part to be admitted to take the final exam
5.2. For the applications	PC, Specific Software Compulsory attendance of 100% to be admitted to take the final exam

6. Specific competence

6.1 Professional competences	analyse big data build predictive models create data models debug software define software architecture develop software prototype interpret technical requirements perform data cleansing perform data mining use data processing techniques use software design patterns use software libraries utilise computer-aided software engineering tools utilise machine learning
6.2 Cross competences	The graduate: • develop an analytical approach • taking a proactive approach • developing strategies to solve problems • being open minded

7. Expected Learning Outcomes

Knowledge	The student has knowledge of: • computer science • data analytics • data models • digital data processing • unstructured data • statistics • software components • software libraries • data analytics
Skills	The student is able to: • create data sets • develop data processing applications • establish data processes • manage data • manage quantitative data • manage research data • perform dimensionality reduction • process data • use data processing techniques • analyse pipeline database information • create data models • debug software • use software design patterns • use software libraries • adapt to changes in technological development plans
Responsibilities and autonomy	The student has the ability to work independently in order to: • develop an analytical approach • take a proactive approach • develop strategies to solve problems • be open minded

8. Discipline objective (as results from the *key competences gained*)

8.1 General objective	Facilitate the understanding of main characteristic of time-series. Knowledge of the techniques, algorithms and methods that can be used; Identification of solutions and design for time series analysis and processing based on a given context
8.2 Specific objectives	In order to achieve this objective, students will learn to: • analyse time series data with statistical tools • process time series data • apply statistical methods for analysing and forecasting time series data • apply machine learning strategies on time-series: clustering, classification, forecasting, anomaly detection, peak demand prediction • determine and optimize parameters • apply state of the art deep learning architecture and tools

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
Time Series Basics: definition and characteristics; Practical examples; Missing data	1	Lectures using blackboard and projector; involving students in debate; Using Moodle and Microsoft Teams	
Time Series Decomposition; Stationarity; Correlation; Autocorrelation;	1		
Spectral analysis; Introduction into forecasting methods; Statistical models for time series forecasting: AR, MA	1		
Statistical Models for Time series Forecasting: ARMA, ARIMA, SARIMA	1		
Vector autoregression; Evaluation of forecasting methods	1		
Machine learning for time series data overview; Feature selection; Cross validation	1		
Clustering of time series data. Methods for comparing time series	1		
Classification of time series data. Bagging vs Boosting strategies.	1		
Regression for time series. Multiple step-ahead prediction. Classical Deep Learning approaches (MLP, CNN, LSTM)	1		
Transformers, Autoencoders	1		
State of the art deep learning architectures for forecasting: N-BEATS, DeepAR, TCN, TFT, TimeGPT	1		
Anomaly detection: Isolation Forest, LSTM Autoencoder. Change point detection	1		
Peak Demand Detection; Strategies for combining multiple models for time series processing	1		
Intermittent time series processing; Croston method; Machine learning approaches	1		

Bibliography:

Practical Time Series Analysis - Aileen Nielsen, O'Reilly 2019

Introduction to Modern Time Series Analysis - Gebhard Kirchgässner , Jürgen Wolters , Uwe Hassle, Springer 2013

Modern Time series forecasting with python. Expert insights - Manu Joseph, Jeffrey Tackes, Packt Publishing Limited 2024

Machine Learning for Time-Series with Python – Ben Auffart, Packt Publishing Limited 2021

Forecasting: Principles and Practice - Rob J Hyndman and George Athanasopoulos, Monash University Australia

9.2 Applications - Seminars	Hours	Teaching methods	Notes
Introduction; Visualisation; Statistical Analysis; Handling missing values;	1	Oral presentation using slides. Discussion (Q&A). Tutorials.	
Correlation testing; Time series decomposition; Stationarity	1		
Statistical models for time series forecasting: AR, MA	1		

Statistical models for time series forecasting: ARMA, ARIMA, SARIMA	1	Using multimedia tools, interactive teaching tools. Using specific software for time series analysis.	
Statistical models for time series forecasting: VAR. Evaluation methods for forecasting	1		
Time series feature extraction: TSFEL, TSFresh libraries	1		
Cross validation. Clustering applied to time series data.	1		
Classification: random forest, xgboost, time series forest	1		
Generating synthetical time series methods: Statistical approaches, TimeGAN, TTS-GAN	2		
Forecasting with a classical deep learning approach; Forecasting with advanced deep learning approach; Anomaly detection in time series	2		
Meta's Prophet. Google's Vertex AI. Uint8's Darts	2		
Bibliography: Practical Time Series Analysis - Aileen Nielsen, O'Reilly 2019 Machine Learning for Time-Series with Python – Ben Auffart, Packt Publishing Limited 2021 Modern Time series forecasting with python. Expert insights - Manu Joseph, Jeffrey Tackes, Packt Publishing Limited 2024			
9.3 Applications - Laboratory	Hours	Teaching methods	Notes
Introduction; Familiarisation with tools (python, pandas; matplotlib, seaborn; scikit-learn); Data visualisation	1	Assignments. Discussion. Using specific software for time series analysis. Moodle and Microsoft Teams	
Statistical Analysis; Handling missing values; Time series decomposition.	1		
Correlation testing; Frequency Domain Decomposition	1		
Time series forecasting using statistical methods	2		
Machine Learning for Time Series Processing: clustering analysis and classification on time series data	3		
Forecasting using traditional ML (xgboost, random forest, SVR).	1		
Forecasting with a classical deep learning approach	1		
Forecasting with advanced deep learning methods	2		
Anomaly detection and peak demand detection in time series	2		
Bibliography: Practical Time Series Analysis - Aileen Nielsen, O'Reilly 2019 Modern Time series forecasting with python. Expert insights - Manu Joseph, Jeffrey Tackes, Packt Publishing Limited 2024			

**Se vor preciza, după caz: tematica seminariilor, lucrările de laborator, tematica și etapele proiectului.*

10. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

11. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Exam	Written Exam – summative evaluation	50%
Seminar	Presentation; Demonstration	Oral examination - summative evaluation	20%
Laboratory	Assignments	Evaluation of assignments during the semester – continuous evaluation	30%

Project	-	-	-
Minimum standard of performance: Lab grade + seminar grade >=5, Course evaluation grade >=5			

Date of filling in: 01.09.2025	**Responsible**	**Title First name Last name**	**Signature**
	Course	Lect.dr.eng. Raluca-Laura PORTASE	
	Applications	Lect.dr.eng. Raluca-Laura PORTASE	

Date of approval in the department 17.09.2025	Head of department Prof.dr.eng. Rodica Potolea
Date of approval in the Faculty Council 19.09.2025	Dean Prof.dr.eng. Vlad Mureșan