



### COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Natural Language and Speech Signal Processing	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: Dr. Gražina Korvel Other(s):	Faculty of Mathematics and Informatics Institute of Data Science and Digital Technologies

Study cycle	Type of the course unit (module)
Second	Compulsory

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Face-to-face	1 <sup>st</sup> (autumn) semester	English/Lithuanian

Requirements for students	
Prerequisites:	Additional requirements (if any): Statistical Data Analysis Methods

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5	125	42	83

**Purpose of the course unit (module): programme competences to be developed**

The goal of the course unit is to introduce the basic principles of human language knowledge from two different perspectives: spoken, which deals with how the speech signal is encoded by the speaker and decoded by the listener, and written, which deals with theories of grammar and meaning. The course focuses on data representation techniques, including feature engineering and representation learning strategies, which are critical for effective machine learning. The course material is structured to present essential concepts in speech and language technology research and how these concepts are used in practical applications such as language understanding, text generation, speech recognition, and speech synthesis. Upon completing the course, students will have the knowledge and skills to develop and apply advanced natural language and speech processing algorithms for complex, real-world applications.

Learning outcomes of the course unit (module)	Teaching and learning methods	Assessment methods
Ability to formulate a text and speech processing problem, relate that problem to a set of known issues, and apply an appropriate solution.	Lectures by the course teacher, study of the research literature, laboratory activities	Laboratory activities and exam. The subject cannot be studied externally.
Ability to conduct appropriate literature searches and analysis on speech and natural language processing topics, gather new knowledge and apply it to problem-solving.		
The ability to reason about possible applications of natural language processing and speech signal processing algorithms in the real world.		
Ability to understand a variety of computational toolkits and data sets used in the field of speech and language processing.		

Content: breakdown of the topics	Contact hours							Self-study work: time and assignments	
	Lectures	Tutorials	Seminars	Exercises	Laboratory work	Internship/work placement	Contact hours	Self-study hours	Assignments
Overview and interrelation of natural language processing and speech processing	2						2	8	
Fundamentals in digital signal processing	4				2		6	12	Fourier transform and filtering techniques, acoustic speech parameter extraction.
Automatic speech recognition	4				2		6	10	Development of speech recognition system
Text-to-speech synthesis	4				2		6	10	Implementing a text-to-speech system

Text processing and regular expressions	4				2		6	12	Clean a text dataset and extract specific information using regular expressions.
Natural language understanding	4				2		6	10	Perform a text classification task
Text generation	4				2		6	10	Design a system that uses a neural network model to generate text
Key real-world challenges and current state of research	2				2		2	11	Adapting to real-world applications
<b>Total</b>	<b>28</b>				<b>14</b>		<b>42</b>	<b>83</b>	

Assessment strategy	Weight, %	Deadline	Assessment criteria
Four laboratory assignments	60	Throughout the course	Criteria for assessing the task: Implementation - 30 points Clarity and accuracy of the report - 40 points Defense of the laboratory work - 30 points
Exam	40	During examination session	The written test will consist of 20 closed-ended and 5 open-ended questions.

Author	Year of publication	Title	Issue of a periodical or volume of a publication	Publishing place and house or web link
<b>Compulsory reading</b>				
Kochmar, Ekaterina	2022	Getting Started with Natural Language Processing		Manning Publications Co. LLC, ProQuest Ebook Central, <a href="https://ebookcentral.proquest.com/lib/viluniv-ebooks/detail.action?docID=7119238">https://ebookcentral.proquest.com/lib/viluniv-ebooks/detail.action?docID=7119238</a>
Zhiyuan Liu et al.,	2023	Representation Learning for Natural Language Processing		Springer, ProQuest Ebook Central, <a href="https://ebookcentral.proquest.com/lib/viluniv-ebooks/detail.action?docID=30718654">https://ebookcentral.proquest.com/lib/viluniv-ebooks/detail.action?docID=30718654</a>
Daniel Jurafsky and James H. Martin	2009	Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition (second edition)		Prentice Hall, <a href="https://web.stanford.edu/~jurafsky/slp3/">https://web.stanford.edu/~jurafsky/slp3/</a>
<b>Optional reading</b>				
Hapke, Hannes, et al.	2019	Natural Language Processing in Action: Understanding, Analyzing, and Generating Text with Python		Manning Publications Co. LLC, ProQuest Ebook Central, <a href="https://ebookcentral.proquest.com/lib/viluniv-ebooks/detail.action?docID=6642558">https://ebookcentral.proquest.com/lib/viluniv-ebooks/detail.action?docID=6642558</a>
Kumar, L. Ashok, and D. Karthika Renuka.	2023	Deep Learning Approach for Natural Language Processing, Speech, and Computer Vision: Techniques and Use Cases,		Taylor & Francis Group, ProQuest Ebook Central, <a href="https://ebookcentral.proquest.com/lib/viluniv-ebooks/detail.action?docID=7206027">https://ebookcentral.proquest.com/lib/viluniv-ebooks/detail.action?docID=7206027</a>
Tuomas Virtanen, et al.	2012	Techniques for Noise Robustness in Automatic Speech Recognition		John Wiley & Sons, Incorporated, ProQuest Ebook Central, <a href="https://ebookcentral.proquest.com/lib/viluniv-ebooks/detail.action?docID=1032417">https://ebookcentral.proquest.com/lib/viluniv-ebooks/detail.action?docID=1032417</a>
Jabbar, M. A., et al.	2021	Machine Learning Methods for Signal, Image, and Speech Processing		River Publishers, ProQuest Ebook Central, <a href="https://ebookcentral.proquest.com/lib/viluniv-ebooks/detail.action?docID=29002971">https://ebookcentral.proquest.com/lib/viluniv-ebooks/detail.action?docID=29002971</a>