COURSE UNIT DESCRIPTION

Course unit title	Course unit code
Signal and Image Analysis and Processing	IVSA7114

Lecturer(s)	Department where the course unit is delivered
Coordinators: prof. Algimantas Juozapavicius, dr. Tadas Meškauskas	Department of Computer Science II Faculty of Mathematics and Informatics Vilnius University

Cycle	Type of the course unit
Second	Compulsory

Mode of delivery	Semester or period when the course unit is delivered	Language of instruction
Auditorium	2nd semester	Lithuanian/English

Prerequisites
Good skills in programming are required, the calculus courses should be taken

Number of ECTS credits allocated	Student's workload	Contact hours	Individual work
6	160	64	96

Purpose of the course unit: programme competences to be developed (in short)
Generic competences to be developed: behave according to ethical principles while applying contributions (results and conclusions) of others, ability to adapt oneself to the real or simulated situation, identify problems, distinguish possible solutions, solve problems in a creative and qualitative manner by applying knowledge in practice. **Subject-specific competences to be developed:** ability to search, analyze, process, and evaluate related information, select reliable sources, especially in signal processing and medical imaging, ability to implement, modify and apply digital signal and images processing, train specialists with competences of the signal and image processing, medical imaging.

Learning outcomes of the course unit	Teaching and learning methods	Assessment methods
Knowledge of basic digital signal and image processing	Lecture (involving, problem-based)	Examination
Ability to analyse, compare and evaluate digital signal and image processing methods and to select an optimal option	Lecture (involving, problem-based)	Examination
Ability to use digital signal and image for specific tasks, especially for medical image processing to understand the alternatives	Project consists of the follow-up tasks; individual analysis of technical literature, consultation	Homework
Ability to find information and learn autonomously, ability to critically analyse signal and image techniques and methods	Project consists of the follow-up tasks; individual analysis of technical	Homework

	literature	

Course content: breakdown of the topics	Individual work: time and assignments							
	Lectures	Tutorials	Seminars	Laboratory work	Internship/work placement	**Contact hours**	**Individual work**	**Assignments**
1. Origin and classifications of signals, analog and digital signals	2			2		**4**	**6**	Working with the literature, designing and constructing theoretical algorithms, evaluating their complexity, designing and programming algorithms, assigned at laboratory works
2. Signal averaging, signal noise reduction	2			2		**4**	**6**	
3. Recurrence plots of a signal	2			2		**4**	**6**	
4. Correlation integral and correlation dimension	2			2		**4**	**6**	
5. Correlation and autocorrelation of signals	2			2		**4**	**6**	
6. Decomposition of a signal, Fourier series	2			2		**4**	**6**	
7. Fast Fourier transform, Fourier filter	4			4		**8**	**12**	
8. 2D and 3D image definition, attributes, sources, shades, shading	2			2		**4**	**6**	
9. Linear filters, Fourier transforms, sampling and aliasing, filters as templates, scale and image pyramid	2			2		**4**	**6**	
10. Gaussian noise, derivatives, smoothing filters, Laplassian, Canny and gradient edge detectors	2			2		**4**	**6**	
11. Texture, representing texture, filter banks, Laplacian pyramid, statistical outputs, oriented pyramids, Gabor filters, synthesizing textures for rendering	2			2		**4**	**6**	
12. Segmentation, segmentation by clustering, grouping and Gestalt, edge detection, K-means, APDF and decision-tree algorithms, graph-theoretical clustering	2			2		**4**	**6**	
13. Fitting models, regular curves, Hough transform, parametric and implicit curves, probabilistic inference problem, M-estimators	2			2		**4**	**6**	
14. Probabilistic segmentation and fitting, missing data problem, EM-algorithms in practice, model selection, principal curves	2			2		**4**	**6**	
15. Tracking with linear dynamic models, abstract inference problem, Kalman filtering, data associations, tracking in 2D and 3D spaces	2			2		**4**	**6**	
Total	**32**			**32**		**64**	**96**	

Assessment strategy	**Weight %**	**Deadline**	**Assessment criteria**
Laboratory works	50%	May	Laboratory work is formulated as a project, students have to develop and implement system, including signals and images
Colloquium	20%	March, May	There are two colloquiums, each evaluated up to 1 point, there are 5-10 questions, reflecting theory and practice
Examination	30%	June	Exam is evaluated up to 3 points, there are 7-10 questions, mostly of theoretical kind

Author	**Publis**	**Title**	**Issue No or**	**Publishing house**

	hing year		volume	or Internet site
Required reading				
David A. Forsyth, Jean Ponce	2003	Computer Vision, a modern approach		Prentice Hall
Richard G. Lyons	2011	Understanding Digital Signal Processing (3rd Edition)		Prentice Hall
John C. Russ	1998	The Image Processing Handbook		CRC Press
Optional reading				
William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery	2003	Numerical Recipes: The Art of Scientific Computing (3rd Edition)		Cambridge University Press
Bernd Jaehne, Horst Haussecker	2000	Computer Vision and Applications. Guide for students and practitioners		Academic Press