RTU Course "Computerization of Mathematical Tasks in Electrical Engineering"

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General data

Code	RTR207
Course title	Computerization of Mathematical Tasks in Electrical Engineering
Course status in the programme	Compulsory/Courses of Limited Choice
Responsible instructor	Māris Tērauds
Academic staff	Raisa Smirnova Sergejs Tjukovs
Volume of the course: parts and credits points	1 part, 4.5 credits
Language of instruction	LV, EN
Annotation	The study course is designed to develop students' skills and skills to work with MATLAB's programming language and give an introduction to Python's programming language. The study course addresses the following topics: programming MATLAB, working with matrices, graphs, linear equation systems, approximation, interpolation, numerical integration, and symbolic mathematics. The study course contains activities related to modeling electronic circuits: for example, we look at the modeling of linear and non-linear electronic circuits in Matlab, as well as the activities related to simulation, such as providing insights into simulating an average and RMS value calculations in the Matlab Simulink environment. The study course is adapted to a combined study methodology. It includes asynchronous and synchronized study activities and the necessary supporting materials for asynchronous study activities (video lectures, interactive materials, laboratory descriptions, homework). Learning a high-performance computation platform would mean more opportunities that could be accomplished in the future after completing this course, and it also includes activities related to the training of a neuron network. Students are also expected to use the high-performance computation platform during the course project, modelling the motion and interaction of multiple particles. By studying the study course, the students acquire digital skills of the highest levels corresponding to the DigComp 7th level of the digital competence framework of European citizens. Nowadays, knowledge of MATLAB and Python is vital. Their application area is wide, from plotting graphs for laboratory work to making calculations for scientific publications. MATLAB is also used in future study courses. The knowledge of MATLAB and Python will also be necessary for future careers, especially in scientific institutes such as the Institute of Electronics and Computer Science or research-related companies such as “SAF tehnika”.
Goals and objectives of the course in terms of competences and skills	The aims of the study course is to develop students' understanding of the numerical methods used in the work of electrical engineers and skills to use them in digital tools to solve various problems in the field of electronics. Tasks of the study course: - to promote the ability to work independently and regularly with literature; - to promote understanding of theoretical material; - to develop independent research work skills; - to achieve the acquisition of skills to solve real engineering business tasks independently in THE MATLAB environment and the ability to develop these skills independently.
Structure and tasks of independent studies	1. Review of lecture. Tests provide control during the lecture. Objective: to promote a lecture learning and encourage regular work. 2. Execution of proposed homework. Objective: to promote skills to work regularly and independently with textbooks. 3. Take a few topics by watching videos and reading interactive materials. Objective: to promote skills to work independently. 4. Preparation for tests. Task to stimulate systematic studies during the semester. 5. Submission of laboratory works, making reports of laboratories. Objective: to raise awareness of the study course's content and develop initial research skills.

Recommended literature	Obligātā/Obligatory: 1. Matlab online documentation: https://se.mathworks.com/help/releases/R2018b/pdf_doc/matlab/index.html?s_cid=doc_ftr, last accessed on 03.02.2022 2. P. Misāns. Ievads inženiermatemātikas datorrealizācijā. Lekciju konspekts. Elektroniskā versija *.pdf datnes formātā, RTU, 2007. 3. P. Misāns. Pirmie soļi darbā ar MATLAB. Lekciju konspekts. – PIMARS, 2003. 4. P. Misāns. Ievads inženiermatemātikas datorrealizācijā. Lekciju konspekts – PIMARS, 2003. Papildu/Additional: 1. W. H. Press et al. Numerical Recipies in C, The Art of Scientific Computing. Cambridge Univ. Press, 1992. 2. G. J. Borse. Numerical Methods with MATLAB. PWS Publishing Company, 1997. 3. L. F. Shampine, R. C. Allen, Jr. S. Pruess. Fundamentals of Numerical Computing, John Willey & Sons Inc., 1997. 4. J. H. Mathews, K. D. Fink. Numerical Methods Using MATLAB. - Pearson Prentice Hall. – 4-th ed. – New Jersey, 2004. 5. R. C. Gonsales, R. E. Woods, S. L. Eddins. Digital Image Processing using MATLAB. – Pearson Prentice Hall. – New Jersey, 2004. 6. J. Vlach, K. Singhal. Computer Methods for Circuit Analysis and Design. Van Nostrand Reinhold Company, NY, 1983. 7. J. B. Dabney, T. L. Harman. Mastering SIMULINK. – Pearson Prentice Hall. – New Jersey, 2004. 8. P. Marchand, O. T. Holland. Graphics and GUIs with MATLAB. – Chapman&Hall/CRC Hall. – New York, 2003. 9. MATLAB/SIMULINK/Toolboxes/Blocksets User Guides for Version 7. – MathWorks, 2004. 10. Kiusalaas, Jaan. Numerical methods in engineering with MATLAB® /2016. 11. H. Kalis. Diferenciālvienādojumu tuvinātās risināšanas metodes. Rīga, Zvaigzne, 1984. 12. A. Zviedris. Datorrealizācijas matemātiskās metodes. Lekciju konspekts. RTU, 1999. 13. P. Misāns. Pirmie soļi darbā ar MATLAB. Lekciju konspekts. – PIMARS, 2003. 14. P. Misāns. Ievads inženiermatemātikas datorrealizācijā. Lekciju konspekts – PIMARS, 2003.
Course prerequisites	Some topics of Calculus (complex numbers, linear algebra, differentiation, integration). Basic skills in advanced programming languages (C or others).

Course contents

Content	Full- and part-time intramural studies		Part time extramural studies	
	Contact Hours	Indep. work	Contact Hours	Indep. work
Basic operations in Matlab environment. (lect., lab 0).	4	2	0	0
Using of symbolic math in the Matlab environment. (lab 1).	2	2	0	0
Building of matrices, Multidimensional matrices (lect.).	2	2	0	0
Processing of measurement data (videolecture, lab 2).	2	2	0	0
Data types in Matlab (videolecture).	0	2	0	0
Functions and scripts in Matlab (videolecture).	0	4	0	0
Logical variables and data filtering in Matlab (videolecture).	0	4	0	0
Building of a piecewise signal (lab 3).	2	2	0	0
Solving linear equations (reading by yourself, lab 4).	2	4	0	0
Solving Non-linear equations (videolecture, lab 5).	2	2	0	0
Optimization problem (lecture).	4	4	0	0
Calculating average and RMS value for the piecewise signal (lab 6).	4	2	0	0
Differential equations (lect., lab 7).	2	2	0	0
Math graphics: handles and interface (lab 8).	4	2	0	0
Training the neural network on a high-performance platform (lab 9).	4	0	0	0
Object-oriented programming approach (lect.).	2	2	0	0
Using a high performance computation platform (lect.).	2	2	0	0
Introduction into Python language (lect.).	4	2	0	0
Coursework.	2	8	0	0
Examination and consultation.	16	10	0	0
Total:	60	60	0	0

Learning outcomes and assessment

Learning outcomes	Assessment methods
Is able to develop a set of algorithmic solutions to a complex problem in the electronics field with many interacting factors, such as creating an application to visualize the movements of multiple electrons, taking into account electron interactions, temperature, applied voltage, and predicting electrical current based on it (DigComp 7.level).	Coursework.
Is able to solve the linear equation system, non-linear equations, and differential equations using symbolic and numerical methods.	Lab 4, 5, 7, tests.
Is able to apply and compare numerical and symbolic methods for finding the average and RMS value of the signal.	Lab 6.
Is able to combine lecture knowledge in the construction of simple 3D graphics images.	Homework related to creating a 3D image.
Is able to use polynomial approximation to visualize experimental data.	Lab 1, test.
Is able to use the various architectures of the artificial neuron network, train them, and compare them to address the electronics challenges, by using high performance computation platform.	Lab 9, homework related on HPC.

Is able to divide the piecewise signal into the pieces and find analytical expressions describing each part.	Lab 3, test.
Is able to create simple scenarios and functions.	Exam.
Is able to do symbolic math calculation.	Lab 2.

Evaluation criteria of study results

Criterion	%
Homework	15
Tests	20
Laboratory works	15
Coursework	30
Exam	20
Total:	100

Study subject structure

Part	CP	Hours			Tests		
		Lectures	Practical	Lab.	Test	Exam	Work
1.	4.5	1.5	0.0	1.5		*	