Subject (course) name: **Modelling and Simulation**		
Field of study: **Computer Science** Specialization:		Subject code: **13** Title graduate: **Engineer**
Type of course: **major course, obligatory**	Course level: **First-cycle studies**	Year: **II** Semester: **IV** Semester: **summer**
Form of classes: **Lectures, Classes, Labs, Seminar, Project**	Number of hours per week: **$2L^E$, 0, 2Lab, 0, 0**	Credit points: **4 ECTS**

GUIDE TO SUBJECT

SUBJECT OBJECTIVES

C1. General knowledge of methods of creating dynamic systems models.

C2. The technique of building computer models of systems and the ability to apply for their behaviour on the basis of computer simulation.

C3. Practical skills in the creation of computer models of dynamical systems.

SUBJECT REQUIREMENTS

1. General knowledge of physics in the field of dynamics.
2. General knowledge of mathematics in the field of the differential equations and the integrals.
3. General knowledge of electrical engineering in the field of circuit theory.
4. General ability to work independently and in groups.
5. General ability to prepare reports on the performed exercises.
6. Computer skills and the use of literature sources and online resources.

LEARNING OUTCOMES

EK 1 - Student is able to characterize the basic concepts of the classification of models, signals, as well as the objectives and methods of modeling and simulation of dynamic systems using computer techniques.

EK 2 - Student distinguishes the structure of control systems and basic dynamic elements based on their parametric and non-parametric description.

EK3 - Student is able to develop a model of a dynamical system for a given task.

EK4 - Student is able to use a universal computing environment to perform a computer system model.

EK4 - Student interprets the simulation results and analyzes the dynamic properties of the system.

SUBJECT CONTENT

Form of classes - lectures

Topic	Hours
W1 –Theory of modelling and simulation	**2**
W2 – Elementary math and linear algebra	**2**
W3 – Numerical integration and differential equations	**2**

W4 – Interpolation, linear regression and polynomial regression	**2**
W5 – Classification of models	**2**
W6 – Transfer functions, analysis of standard functions	**2**
W7 – Continuous-time and discrete-time systems	**2**
W8 – Modelling methods for complex systems	**2**
W9 – Numerical methods for simulation	**2**
W10 – Modelling of electrical systems	**2**
W11 – Modelling of electromechanical systems	**2**
W12 – State-space models	**2**
W13 – Frequency response and stability analysis of feedback systems	**2**
W14 – Control system design and analysis	**2**
W14 – Final test	**2**
Total	**30**

Form of classes – laboratory

Topic	Hours
Lab1 – Introduction to Matlab/Simulink. Modeling simple first-order system	**2**
Lab2 – Modeling and numerical solution of ordinary differential equations in Matlab	**2**
Lab3 – Transfer function models of linear dynamical systems	**2**
Lab4 – Frequency characteristics of transfer function models	**2**
Lab5 – State-space (matrix) models of multi-input multi-output linear dynamical systems	**2**
Lab6 – Modeling and simulation of nonlinear dynamic systems using Matlab	**2**
Lab7 - Modeling and simulation of electromechanical systems using Simulink block diagrams	**2**
Lab8 – Modeling and simulation of a discrete-time process	**2**
Lab9-10 – Visualization and simulation of dynamic systems using Simulink and Virtual Reality Modeling Language (VRML)	**4**
Lab11 – Modeling and simulation of a distributed-parameter thermal system using difference equations	**2**
Lab12 – Modeling and simulation of an event-driven system	**2**
Lab13-14 – Matlab/Simulink project	**4**
Lab15 – Final test	**2**
Total	**30**

STUDY METHODS

1. Lectures using multimedia presentations
2. Discussion during the course and in addition during individual consultations
3. Laboratory - working with computers

EDUCATIONAL TOOLS

1. Audiovisual equipment, black(white)board, lectures in electronic version
2. Manuals to perform laboratory exercises
3. Computers in the laboratory with the Matlab/Simulink software

METHODS OF ASSESMENT (F – Forming, P – Summary)

F1. Assessment of self preparation for laboratory classes – oral answer
F2. Assessment of the correct and timely preparation of laboratory reports
P1. Lecture - written test of the theory and computational tasks, final exam
P2. Laboratory - assessment of the ability to correctly implementation of laboratory exercises
P3. Laboratory - assessment of the ability to solve complex tasks and drawing conclusions

STUDENT WORKLOAD

Form of activity	Averaged workload (hours)		
	[h]	$\sum$ [h]	ECTS
Participation in class activities lecture	30	60	2
laboratory	30		
Preparation for laboratory classes (reading literature)	10	50	2
Familiarizing yourself with the specialized software	10		
Preparation of laboratory reports	15		

Preparation for the final test	15		
Total		**110**	**4**

A. BASIC READING

1. Chaturvedi D. K.: Modeling and Simulation of Systems Using MATLAB and Simulink. CRC Press,Taylor & Francis Group, 2009.

2. Gray M. A.: Introduction to the Simulation of Dynamics Using Simulink. Chapman & Hall/CRC Computational Science, 2010.

2. Fishwick P. A.: Handbook of Dynamic System Modeling. Chapman & Hall/CRC Computer and Information Science Series, 2007.

B. FURTHER READING

1. Hawryszkiewycz I. T.: Introduction to Systems Analysis and Design. Prentice Hall, 2001.

2. Website: http://www.mathworks.com/

Learning objectives	In relation to the learning outcomes specified for the field of study	Subject objectives	Study methods	Methods of assessment
EK1	K_W01	C1	Lecture	P1
EK2	K_W01	C1	Lecture	P1
EK3	K_U07	C2, C3	Laboratory	F1, F2, P2
EK4	K_U07	C2, C3	Laboratory	F1, F2, P3
EK5	K_U10	C3	Laboratory	F2, P3

II. EVALUATION

Grade	Outcome
EK1	**Student is able to characterize the basic concepts of the classification of models, signals, as well as the objectives and methods of modeling and simulation of dynamic systems using computer techniques.**
2 (F)	Student is not able to present the classification of models and signals, and determine stages, goals and methods of modeling and simulation systems
3 (E)	Student is able to classify the models and signals and the objectives of modeling and simulation
4 (C)	Student is able to characterize the models and signals, as well as describe the stages and objectives of modeling and simulation systems
5 (A)	Student is able to characterize the models and signals, describe the modeling stages and objectives and give examples
EK2	**Student distinguishes the structure of control systems and basic dynamic elements based on their parametric and non-parametric description**
2 (F)	Student is not able to distinguish the basic dynamic elements
3 (E)	Student is able to distinguish the basic dynamic elements
4 (C)	Student is able to characterize the structure of control systems, the basic dynamic elements and their parametric description
5 (A)	Student is able to characterize the structure of control systems, the basic dynamic elements and their parametric non-parametric description
EK3	**Student is able to develop a model of a dynamical system for a given task**
2 (F)	Student is not able to select the model for a given system
3 (E)	Student is able to select the form of the model for a given system
4 (C)	Student is able to properly develop a simple model of a dynamical system
5 (A)	Student is able to properly develop a complex model of a dynamical system
EK4	**Student is able to use a universal computing environment to perform a computer system model**
2 (F)	Student is not able to use a universal computing environment for modeling
3 (E)	Student is able to use a universal computing environment for modeling
4 (C)	Student is able to develop a computer model of a simple system and run it
5 (A)	Student is able to develop a computer model of a complex system and run it for the given initial conditions
EK5	**Student interprets the simulation results and analyzes the dynamic properties of the system**

2 (F)	Student is not able to interpret the results of simulations
3 (E)	Student is able to present methods to analyze the dynamic properties of the system
4 (C)	Student correctly interprets the results and the properties of the test system
5 (A)	Student correctly interprets the results of the simulation, the properties of the test system and the influence of the initial conditions

III. OTHER USEFUL INFORMATION

1. All information for students on the schedule are available on the notice board and on the website: www.el.pcz.czest.pl
2. Information on the consultation shall be provided to students during the first lecture and will be placed on the website www.el.pcz.czest.pl
3. Terms and conditions of teaching classes will be provided to students during the first lecture