Bachelor program,
Instrumentation Engineering (INEN) program, “Instrumentation Engineering” department

Course Unit Title	**Systems modeling and simulation**
Course Unit Code	VTES-B04-1
Type of Course Unit	Elective
Level of Course Unit	3rd year INEN program
National Credits	
Number of ECTS Credits Allocated	8
Theoretical (hour/week)	2
Practice (hour/week)	2
Laboratory (hour/week)	2
Year of Study	3
Semester when the course unit is delivered	5
Course Coordinator	Assoc. Prof. Ismailov Bahram
Name of Lecturer (s)	Assoc. Prof. Ismailov Bahram
Name of Assistant (s)	-
Mode of Delivery	Face to Face, Seminar.
Language of Instruction	English
Prerequisites	-
Recommended Optional Program Components	-

Course description:

In the course "Systems modelling and simulation" students study the basics of modelling processes in systems and conducting computer simulations of the developed models. During the training, students become familiar with the principles of building system models, study the methods of using software for computer modelling of the built model. In laboratory classes, students apply the acquired knowledge to build models, test their performance, interpret the results obtained and make decisions based on their results. In seminars, students discuss lecture material in a practical context, compare the capabilities of the developed models and the possibilities of their simulation to obtain the expected results..

Objectives of the Course:

The goal of the course is to introduce students to modern methods, algorithms, software and approaches to modelling various processes using computers for research and cognitive activities. During the training, students study methods for constructing system models, methods for checking constructed models, assessing their dynamics and behavior, and become familiar with methods for applying mathematical and logical relationships. Computer modelling allows students to evaluate the dynamics of system development and assess the applicability of alternative impact options. During the training, students will gain knowledge and experience in using simulation modelling in various production areas..

Learning Outcomes:

At the end of the course the student will be able to		Assessment
1	Have knowledge of modeling systems of varying complexity;	1, 3
2	Be able to select modeling and simulation methods;	1, 3
3	Predict the efficiency of the modeled system;	1, 3
4	Be able to design models that meet the requirements of the technological process or research project;	1, 3
5	Apply the acquired knowledge to verification - simulation of the created model, adjust its functions.	1, 3

Assessment Methods: 1. Final Exam, 2. Presentation, 3. Midterms

Course’s Contribution to Program

		CL
1	Ability to create models of technical devices of varying complexity using computer programs.	3
2	Ability to use the basics of mathematics, algorithmic principles and methods of computer technology in modelling.	1
3	Ability to conduct laboratory work on modelling static and dynamic processes using examples of various systems.	4
4	Ability to use modern software to solve a given modelling problem.	1
5	Ability to adjust and configure modes for performing design tasks, as well as the ability to eliminate modelling errors.	1

6	Ability to conduct correct testing methods and adapt the model to achieve a given goal.	4
7	Ability to use language skills to share and acquire some knowledge from foreign sources.	1
8	Ability to analyze a problem, identify key requirements, justify an idea, and critically evaluate and compare results.	4
9	Ability to understand the professional, ethical, legal, and safety issues and responsibilities specific to engineering.	3
10	Ability to work productively in multidisciplinary teams, especially on projects requiring engineering skills, and to carry out all work in accordance with relevant laws, regulations, standards, practices, and guidelines.	3
CL: Contribution Level (1: Very Low, 2: Low, 3: Moderate, 4: High, 5: Very High)		

Course Contents

Week	Chapter	Topics	Exam
1	[1] Ch.1, p.1-6 [3] Ch.4, p.150-153	**LECTURE:** Basic concepts of Systems modelling & simulation **LAB –** Introduction to Modeling of dynamic systems **SEMINAR:** System Configurations. Analysis and Design Objectives	
2	[1] Ch.1, p.12-40 [3] Ch.4, p.154-159 [4] Ch.2, p. 34-36	**LECTURE:** Simulation of a Single-Server Queueing System **LAB -** Mathematical modeling of material systems **SEMINAR:** Modeling Methods for Complex Systems	
3	[1] Ch.1, p.61-71 [2] Ch.2, p.180-190 [2] Ch.2, p.116-139	**LECTURE:** Parallel/Distributed Simulation and the High Level Architecture. Advantages, Disadvantages of Simulation **LAB –** Modeling mechanical systems function **SEMINAR:** Modeling in the Frequency Domain	
4	[1] Ch.2, p.85-92 [2] Ch.2, p.190-196 [2] Ch.3, p.237-251	**LECTURE:** Modeling Complex Systems **LAB -** Modeling of rotational mechanical system function **SEMINAR:** Modeling in the Time Domain	
5	[1] Ch.3, p.183-193 [3] Ch.4, p.164-167 [4] Ch.2, p.43-47	**LECTURE:** Classification of Simulation Software. Desirable Software Features **LAB -** Mathematical modeling of electric systems **SEMINAR:** Mathematical Modeling of Physical Systems	
6	[1] Ch.4, p.214-225 [3] Ch.3, p.138-145 [4] Ch.3, p. 103-105; 127-131	**LECTURE:** Basic Probability and Statistics **LAB -** Modeling measurement filters **SEMINAR:** Formulation of System Model for Physical Systems	
7	[1] Ch5, p.246-255 [2] Ch.6, p.529-537 [2] Ch.5, p.473-477	**LECTURE:** Building Valid, Credible, and Appropriately Detailed Simulation Models **LAB -** Modeling of system stability **SEMINAR:** Analysis and Design of Feedback Systems	
8	[1] Ch.5, p.255-268 [2] Ch.6, p.537-542 [2] Ch.6, p.529-536; [4] Ch.3 p.184-186	**LECTURE:** Techniques for Increasing Model Validity and Credibility **LAB -** Modeling of complex problem **SEMINAR:** Analysis stability of systems	Include Midterm exam.
9	[1] Ch.5, p.269-276 [3] Ch.7, p.201-210 [4] Ch.7, p.327-329	**LECTURE:** Statistical Procedures for Comparing Real-World **LAB –** Simulation algorithms of state space models **SEMINAR:** System Dynamics Techniques	
10	[1] Ch.6, p.279-315 [3] Ch.7, p.211-214 [4] Ch.7, p.333-344	**LECTURE:** Selecting Input Probability Distributions **LAB -** Static and Dynamic test of the simulator **SEMINAR:** Structure of a System Dynamic Model	
11	[1] Ch.6, p.316-319 [4] Ch.12, p.616-619 [4] Ch.8, p.401-404	**LECTURE:** Techniques for Assessing Sample Independence **LAB –** Random Number Generation **SEMINAR:** Simulation, advantages	
12	[1] Ch.7, p.393-408 [4] Ch.10, p.508-525 [4] Ch.8, p.404-406	**LECTURE:** Random-Number Generators **LAB -** Building ANN Model **SEMINAR:** Application of Simulation	
13	[1] Ch.8, p.426-437 [3] Ch.31, p.669-675	**LECTURE:** Generating Random Variates **LAB -** Stochastic signals, white and colored noises	

	[4] Ch.9, p.433-435	**SEMINAR:** Nonlinear and Chaotic System	
14	[1] Ch.9, p.488-493 [3] Ch.40,41 p.798-802 [4] Ch.9, p.487-492	**LECTURE:** Output Data Analysis for a Single System **LAB -** Introduction to the Python Control package **SEMINAR:** Bifurcations and Catastrophes	
15	[1] Ch.10, p.556-563 [4] Ch. A16, p.636-640 [4] Ch.10, p.503-505	**LECTURE:** Comparing Alternative System Configurations **LAB –** Basic plotting in MATLAB **SEMINAR:** Modeling with Artificial Neural Network	
16			Final exam

Recommended Sources:
TEXTBOOK(S)

[1] - Simulation Modeling and Analysis. Averill M. Law. McGraw-Hill Education. 2015, 800p**.**
[2] **-** Control systems engineering. Norman S. Nise. Wiley. 2019, 1736p.
[3] - Modeling, Simulation and Control. Finn Aakre Haugen. ISBN 978-82-91748-20-7 Edition 21. 2023, 884p.
[4] - Modeling and simulation of systems using MATLAB. Devendra K. Chaturvedi. Taylor and Francis Group. 2010, 734p.

Assessment

Attendance	0%	At least 75% class attendance is compulsory
Presentation	20%	
Seminars	0%	
Midterm Exam	30%	Written Exam
Final Exam	50%	Written-Exam
Total	100%	

Assessment Criteria
Final grades are determined according to the Academic Regulations of ASOIU for undergraduate studies

Course Policies

- Attendance of the course is mandatory.
- Late assignments will not be accepted unless an agreement is reached with the lecturer.
- Students cannot use calculators during the exam.
- Cheating and plagiarism will not be tolerated. Cheating will be penalized according to the Azerbaijan State Oil and Industrial University General Student Discipline Regulations

ECTS allocated based on Student Workload

Activities	Number	Duration (hour)	Total Workload(hour)
Course duration in class	**14**	**3**	**42**
Presentation	1	9	9
Tutorials	14	1	14
Midterm Examination	1	3	3
Preparation for midterm exam	1	9	9
Final Examination	1	3	3
Preparation for final exam	1	18	18
Self-study	14	4	56
Total Workload			**150**
Total Workload/30(h)			**150/30**
ECTS Credit of the Course			**5**