Bachelor program,
Instrument Engineering (INEN) program, "*Instrument Engineering" department

Course Unit Title	Classical and Fuzzy Logic
Course Unit Code	VTES-B08
Type of Course Unit	Compulsory
Level of Course Unit	4th year INEN program
National Credits	0
Number of ECTS Credits Allocated	7
Theoretical (hour/week)	2
Practice (hour/week)	2
Laboratory (hour/week)	2
Year of Study	4
Semester when the course unit is delivered	7
Course Coordinator	Kamala Aliyeva
Name of Lecturer (s)	Kamala Aliyeva
Name of Assistant (s)	-
Mode of Delivery	Face to Face, Seminar.
Language of Instruction	English
Prerequisites	-
Recommended Optional Program Components	-

Course description:

Fuzzy Sets and Fuzzy Logic is a true magnum opus. An enlargement of Classical and Fuzzy Logic addresses practically every significant topic in the broad expanse of the union of fuzzy set theory and fuzzy logic. The course Classical and Fuzzy Logic is a remarkable achievement; it covers its vast territory with impeccable authority, deep insight and a meticulous attention to detail. To view Fuzzy Sets and Fuzzy Logic in a proper perspective, it is necessary to clarify a point of semantics which relates to the meanings of fuzzy sets and fuzzy logic.

Objectives of the Course:

This course, fuzzy logic is interpreted in a sense that is close to FL. However, to avoid misunderstanding, the title refers to both fuzzy sets and fuzzy logic.

Underlying the organization of Fuzzy Sets and Fuzzy Logic is a fundament you learn a set of methods and the conditions under which it is appropriate for you to use those methods.

Learning Outcomes

At the end of the course the student will be able to		Assessment
1	Present and describe fuzzy data and information properly.	1,3
2	Draw conclusions about large populations, using fuzzy logic methods.	1,2,3
3	Make reliable decision by using fuzzy multicriteria decision making methods.	1

Assessment Methods: 1. Final Exam, 2. Presentation, 3. Midterm exam

Course's Contribution to Program

		CL
1	Ability to develop as a specialist in the field of fundamental sciences and apply basic knowledge.	3
2	Ability to analyze and model functional and structural schemes of various purpose devices and systems.	5
3	Ability to use modern methods and tools, creation, selection, and application of engineering and information technology tools and modern devices and equipment.	5
4	The ability to use the strategy of team cooperation in the exchange of information, knowledge, and experience to achieve the set goal.	4
5	As a result of training, the ability to use engineering knowledge, mathematical models, and basic concepts of physics and chemistry in production and technological processes,	5

	automation, measurement, and control systems.	
6	The ability to use modern software to process technical documents of devices, design their structures, and algorithmize processes.	4
7	The ability to apply artificial intelligence to improve the quality characteristics of measurement and control systems.	4
8	The ability to process information acquisition, processing, and transmission processes based on schematic and programmable logical integrated circuits.	4
9	Ability to use knowledge to improve quality indicators and environmental safety of production processes.	5
10	Self-development ability to apply theoretical and experimental knowledge in solving modern engineering problems.	5

CL: Contribution Level (1: Very Low, 2: Low, 3: Moderate, 4: High, 5: Very High)

Course Contents

Week	Chapter	Topics	Exam
1	[1]: Chapter 1	**Introduction, Classical Sets and Fuzzy Sets** Background, Uncertainty and Imprecision, Statistics and Random Processes, Uncertainty in Information, Fuzzy Sets and Membership, Chance versus Ambiguity. Classical Sets - Operations on Classical Sets, Properties of Classical (Crisp) Sets, Mapping of Classical Sets to Functions Fuzzy Sets - Fuzzy Set operations, Properties of Fuzzy Sets. Sets as Points in Hypercubes	
2	[1]: Chapter 2	**Classical Relations and Fuzzy Relations** Cartesian Product, Crisp Relations- Cardinality of Crisp Relations, Operations on Crisp Relations, Properties of Crisp Relations, Composition. Fuzzy Relations - Cardinality of Fuzzy Relations, Operations on Fuzzy Relations, Properties of Fuzzy Relations, Fuzzy Cartesian Product and Composition, Non-interactive Fuzzy Sets. Tolerance and Equivalence Relations - Crisp Equivalence Relation, Crisp Tolerance Relation, Fuzzy Tolerance and Equivalence Relations. Value Assignments - Cosine Amplitude, Max-min Method, Other Similarity methods.	
3	[1]: Chapter 3	**Membership Functions** Features of the Membership Function, Standard Forms and Boundaries, Fuzzification, Membership Value Assignments – Intuition, Inference, Rank Ordering, Angular Fuzzy Sets, Neural Networks, Genetic Algorithms, Inductive Reasoning.	
4	[1]: Chapter 4	**Fuzzy-to-Crisp Conversions, Fuzzy Arithmetic** Lambda-Cuts for Fuzzy Sets, Lambda-Cuts for Fuzzy Relations, Defuzzification Methods Extension Principle - Crisp Functions, Mapping and Relations, Functions of fuzzy Sets – Extension Principle, Fuzzy Transform (Mapping), Practical Considerations, Fuzzy Numbers Interval Analysis in Arithmetic, Approximate Methods of Extension - Vertex method, DSW Algorithm, Restricted DSW Algorithm, Comparisons, Fuzzy Vectors	
5	[1]: Chapter 5	**Classical Logic and Fuzzy Logic** Classical Predicate Logic – Tautologies, Contradictions, Equivalence, Exclusive OR and Exclusive NOR Logical Proofs, Deductive Inferences. Fuzzy Logic, Approximate Reasoning, Fuzzy Tautologies, Contradictions, Equivalence and Logical Proofs, Other forms of the Implication Operation, Other forms of the Composition Operation.	

6	[1]: Chapter 6	**Fuzzy Rule- Based Systems** Natural Language, Linguistic Hedges, Rule-Based Systems - Canonical Rule Forms, Decomposition of Compound Rules, Likelihood and Truth Qualification, Aggregation of Fuzzy Rules, Graphical Techniques of Inference.	
7	[1]: Chapter 7	**Fuzzy Decision Making** Fuzzy Synthetic Evaluation, Fuzzy Ordering, Preference and consensus, Multicriteria Decision Making, Fuzzy Bayesian Decision Method, Decision Making under Fuzzy States and Fuzzy Actions.	Midterm
8		**MIDTERM EXAM**	
9	[1]: Chapter 8	**Fuzzy Classification** Classification by Equivalence Relations - Crisp Relations, Fuzzy Relations. Cluster Analysis, Cluster Validity, c-Means Clustering - Hard c-Means (HCM), Fuzzy c-Means (FCM). Classification Metric, Hardening the Fuzzy c-Partition, Similarity Relations from Clustering.	
10	[1]: Chapter 9	**Operations on fuzzy sets and relations** Operations on fuzzy sets and relations, classical set operations Vs fuzzy set operations.	
11	[1]: Chapter 10	**Properties of fuzzy set, fuzzy logic control principles** Properties of fuzzy set – fuzzy logic control principles in industries	
12	[1]: Chapter 11	**Fuzzy relations – Fuzzy rules – Defuzzification.**	
13	[1]: Chapter 12	**Fuzzy multi criterial decision-making methods** Vicor Methodology Electre Methodology SAW Methodology	
14	[1]: Chapter 13	**Fuzzy AHP Methodology** Determining eigenvalues and eigen vectors. Consistency Analyzing.	
15	[1]: Chapter 14-15	**Fuzzy TOPSIS Methodology** Ideal Solutuon Method, Determining positive and negative solution.	
16		Final	Exam

Recommended Sources

TEXTBOOK(S)

1. Aliyeva K.R. Classical and Fuzzy Logic, 2024, Textbook.
2. Zadeh. A. , Aliev R.A. Fuzzy Logic Theory and Applications: Part I and Part II, WSPC, December, 2018.
3. Zadeh. A. Fuzzy logic: principles, perspectives, and applications.

Assessment

Attendance	0%	At least 75% class attendance is compulsory
Presentation	10%	
Quiz	5%	
Lab. works	10%	
Course work	10%	
Midterm Exam	15%	Written Exam
Final Exam	50%	Written- Exam
Total	100%	

Assessment Criteria

Final grades are determined according to the Academic Regulations of Azerbaijan State Oil and Industry University 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 (including midterm)	15	6	90
Presentation	1	10	10
Tutorials	15	1	15
Preparation for midterm exam	1	10	10
Final Examination	1	3	3
Preparation for final exam	1	22	22
Self-study	15	4	60
Total Workload			**210**
Total Workload/30(h)			**210/30**
ECTS Credit of the Course			**7**