Instrumentation engineering (INEN) program, "Instrumentation engineering" department

Course Unit Title	Measurement Technologies
Course Unit Code	VTSS-B11
Type of Course Unit	Compulsory
Level of Course Unit	3rd year INEN program
National Credits	6
Number of ECTS Credits Allocated	6
Theoretical (hour/week)	2
Practice (hour/week)	1
Laboratory (hour/week)	2
Year of Study	3
Semester when the course unit is delivered	4
Course Coordinator	Kamran Aliyev
Name of Lecturer (s)	Kamran Aliyev
Name of Assistant (s)	-
Mode of Delivery	Face to Face
Language of Instruction	English
Prerequisites	-
Recommended Optional Programme Components	-

Course description:

This course offers an in-depth exploration of the principles, methods, and technologies used in modern measurement systems. Students will study the architecture of measurement systems, focusing on measurement errors, uncertainty, and the standards utilized in the field. The course covers both direct current (DC) and alternating current (AC) measurement techniques, including the use of voltmeters, ammeters, and bridges for the measurement of resistance, capacitance, and inductance across a wide frequency range. Through hands-on lab exercises, students will investigate practical aspects such as error analysis, DC and AC null measurement methods, and the application of various bridge circuits. The course includes the study of advanced instruments such as electrostatic, electrodynamic, and electronic voltmeters. Emphasis is placed on accurate measurement of physical quantities, phase and frequency analysis, and the application of measurement standards in industrial and scientific contexts. By the end of the course, students will gain both theoretical knowledge and practical experience in a wide range of measurement technologies, preparing them for advanced work in instrumentation and automation fields.

Objectives of the Course:

By the end of this course, students will understand the architecture and components of modern measurement systems, be able to analyze and minimize measurement errors, including relative and absolute errors, gain proficiency in applying international standards for measuring resistance, capacitance, inductance, and time, and perform calibration procedures. They will also develop skills in DC and AC measurement techniques using bridge circuits, voltmeters, and ammeters, perform accurate electrical measurements of voltage, current, resistance, capacitance, and inductance across a wide frequency range, and understand and apply the concept of uncertainty in measurements to improve accuracy. Additionally, students will use and troubleshoot DC and AC bridge circuits for precise measurements and develop problem-solving skills in measurement and instrumentation systems through hands-on laboratory work.

Learning Outcomes

At the end of the course the student will be able to		Assessment
1.	Understand the architecture and components of modern measurement systems, and apply measurement standards.	1,3
2.	Analyze and minimize measurement errors, including relative and absolute errors, to improve accuracy.	1,2,3
3.	Perform DC and AC measurement techniques using bridge circuits, voltmeters, and ammeters.	2,3
4.	Accurately measure voltage, current, resistance, capacitance, and inductance over a wide frequency range.	2,3
5.	Utilize and troubleshoot DC and AC bridge circuits for precise electrical measurements.	1,3

6.	Develop practical problem-solving skills through hands-on laboratory work in measurement and instrumentation systems.	1,3
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 scINENces and apply basic knowledge.	4
2	Ability to analyze and model functional and structural schemes of various purpose devices and systems.	3
3	Ability to use modern methods and tools, creation, selection, and application of engineering and information technology tools and modern devices and equipment.	4
4	The ability to use the strategy of team cooperation in the exchange of information, knowledge, and experience to achieve the set goal.	5
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, automation, measurement, and control systems.	4
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.	1
8	The ability to process information acquisition, processing, and transmission processes based on schematic and programmable logical integrated circuits.	3
9	Ability to use knowledge to improve quality indicators and environmental safety of production processes.	4
10	Self-development ability to apply theoretical and experimental knowledge in solving modern engineering problems.	4
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.1-2;	**LECTURE:** Architecture of measurement systems **LAB-** Investigation of measurement errors (Relative and absolute error for measurements)	
2	[1], Ch. 1, p.4;	**LECTURE:** Uncertainty in measurements **LAB-** Measurement of unknown resistance **SEMINAR**: Investigation of measurement errors	
3	[1], Ch. 1, p.4	**LECTURE:** Standards used in measurements **LAB-** Wheatstone measuring bridge	
4	[1], Ch. 1, p.4;	**LECTURE:** Capacitance standard. Inductance standard. Time and frequency standards. **LAB-** Measurement of very small unknown resistances **SEMINAR**: DC Null Methods of Measurement	
5	[1], Ch.4;	**LECTURE:** DC Null Methods of Measurement **LAB-** Double Kelvin bridge.	
6	[1], Ch. 5;	**LECTURE:** AC Null Measurements **LAB-** Measurement of unknown capacity **SEMINAR**: AC Null Measurements	
7	[1], Ch.5, p.5;	**LECTURE:** Capacitance measuring bridges **LAB-** Schering bridge and Parallel Capacity Bridge	Midterm
8	[1], Ch. 5, p.6;	**LECTURE:** Bridges measuring inductance. **LAB-** Measurement of unknown inductance **SEMINAR**: Electrostatic voltmeter. Electrodynamic voltmeter. DC electronic voltmeter.	
9		**LECTURE:** Bridges measuring inductance and mutual inductance.	

	[1], Ch. 5, p.6;	**LAB**- Measurement of unknown inductance with Parallel L bridge	
10	[1], Ch.5, p.5;	**LECTURE:** Measurement of direct current (DC) voltage **LAB-** Maxwell Bridge	
11	[1], Ch 8, p.2	**LECTURE:** Electrostatic voltmeter. Electrodynamic voltmeter. DC electronic voltmeter. **LAB-** Measurement of direct current voltage **SEMINAR**: Measurement of direct current. Electromechanical DC ammeters. DC electronic ammeters.	
12	[1], Ch. 8, p.4;	**LECTURE:** Measurement of direct current. Electromechanical DC ammeters. DC electronic ammeters **LAB-** Schematic of a voltmeter connected to the equivalent voltage source of the Thevenin	
13	[1], Ch 8, p.6;	**LECTURE:** Alternating current (AC) analog electronic voltmeters. Measurement of alternating current (AC) **LAB-** Electromechanical DC ammeters. Schematic of a shunt direct current microammeter **SEMINAR**- Phase, frequency calculations	
14	[1],Ch.8, p.8;	**LECTURE:** Phase, frequency and period (time) measurements in alternating current circuits **LAB-** Measurement of alternating current voltage. D'Arsonval Schematic of a rectifier alternating current voltmeter.	
15	[1],Ch 8,p.10;	**LECTURE:** Measurement of resistance, capacitance and inductance over a wide frequency range **LAB-** Performing direct current measurements with a digital multimeter **SEMINAR**: Resistance measurement. The first scheme for measuring resistance by voltmeter-ammeter method.	
16			Final exam

Recommended Sources

TEXTBOOK(S)

1. N.B.Northrop, 2018,Introduction to Instrumentation and Measurements, 3rd Edition, CRC Press, Taylor@Francis Group
2. Thomas L. Floyd. Electronics Devices. Conventional Current Version. Tenth Edition. Pearson Education, Inc. Copyright 2008, 2012, 2018, 956 p.
3. Floyd. Thomas I. Analog fundamentals: a systems approach / Thomas L. Floyd. David M. Buchla. Pearson Education, Inc. Copyright 2013, 767 p.

Assessment

Attendance	0%	Less than 75% class attendance results in NA grade
Presentation	10%	
Lab	10%	
Quiz	10%	
Midterm Exam	20%	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 İndustry University for undergraduate studies

Course Policies

- Attendance of the course is mandatory.
- Material presented in the lecture as well as assigned readings will be included in testing.
- Late assignments will not be accepted unless an agreement is reached with the lecturer.
- 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	15	5	75
Presentation	1	10	10
Self-study	15	2	30
Tutorials	15	2	30
Midterm Examination	1	3	3
Preparation for midterm exam	1	15	15
Final Examination	1	3	3
Preparation for final exam	1	20	20
Total Workload			186
Total Workload/30(h)			6.2
ECTS Credit of the Course			6