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

Course Unit Title	Microprocessors and Microcontrollers
Course Unit Code	VTSS-B17
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	5
Course Coordinator	Yusubov Elvin
Name of Lecturer (s)	Yusubov Elvin
Name of Assistant (s)	-
Mode of Delivery	Face to Face
Language of Instruction	English
Prerequisites	-
Recommended Optional Programme Components	-

Course description:

A microcontroller (MCU for microcontroller unit) is a small computer on a single metal-oxide-semiconductor (MOS) integrated circuit chip. In modern terminology, it is similar to, but less sophisticated than, a system on a chip (SoC); a SoC may include a microcontroller as one of its components.

Objectives of the Course:

The main objective and purpose of the course is to teach future instrumentation engineers the main types of microcontrollers, and their working principles to evaluate, and improve the performance of their technical characteristics.

Learning Outcomes

At the end of the course the student will be able to		Assessment
1.	Understand fundamentals of microprocessor and microcontrollers.	1,3
2.	Understand the architecture of STM32 microcontrollers	1,2,3
3.	Modify general-purpose input and output units of STM32 microcontrollers	2,3
4.	Modify analog-digital and digital-analog converters of STM32 microcontrollers	2,3
5.	Modify timers and DMA units of STM32 microcontrollers	1,3
6.	Establish interface between the microcontrollers and sensors	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	4

	basic concepts of physics and chemistry in production and technological processes, 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.	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	[3], Ch. 1, p.2-9;	**LECTURE:** Introduction to Microprocessors and Microcontrollers **LAB**- Introduction microcontroller programming softwares	
2	[1], Ch. 1, p.1-5; [1], Ch. 2, p.1-5;	**LECTURE:** Fundamentals of microcontroller programming using assembly, DATA representation embedded C, and C+ languages **LAB**- Practicing necessary C/C+ tools for STM32 microcontrollers **SEMINAR**: Performing bitwise logic operations and constructing functions	
3	[2], Ch. 6, p.1-2	**LECTURE:** Reset and Clock control **LAB**- Configuring RCC registers in microcontrollers	
4	[1], Ch. 14, p.1-3; [2], Ch. 8, p.1-4;	**LECTURE:** General-purpose input devices **LAB**- Pull Down input switch state reading at Register Level using STM32 microcontroller **SEMINAR**: Calculating clock frequency	
5	[1], Ch.1, p.4,5; [2], Ch. 8, p.1-4;	**LECTURE:** General-purpose output devices **LAB**- Pull Up input switch state reading at Register Level using STM32 microcontroller	
6	[1], Ch. 20, p.1-12; [2], Ch. 13, p.1-13;	**LECTURE:** Analog-to-digital converter (ADC) in microcontrollers **LAB**- Basic LED blinking using General-purpose output devices at Register level using STM32 microcontroller **SEMINAR**: Writing code for multichannel ADC usage at the register level	
7	[1], Ch. 21, p.1-7; [2], Ch. 14, p.1-5;	**LECTURE:** Digital-to-analogue converter (DAC) in microcontrollers **LAB**- Led control with a sliding switch at register level using STM32 microcontroller **SEMINAR**: Writing code for multichannel DAC usage at the register level	Midterm
8	[1], Ch. 11, p.1-9;	**LECTURE:** Fundamentals of Interrupts **LAB**- Led control with one push button-register level programming using a STM32 microcontroller **SEMINAR**: Solving tasks using PWM 1 time diagrams	
9	[2], Ch. 12, p.1,2;	**LECTURE:** Interrupts and events **LAB**- Led control with one push button-register level programming in interrupt mode using a STM32 microcontroller **SEMINAR**: Solving tasks using PWM 2 time diagrams	
10	[1], Ch. 19, p.1-6; [2], Ch. 10, p.1-5;	**LECTURE:** Fundamentals of Direct Memory Address (DMA) **LAB**- Performing ADC integer Reading at Register level using a STM32 microcontroller	
11	[1], Ch 15, p.1,2	**LECTURE:** Fundamentals of Timers **LAB**- Performing ADC float Reading at Register level using a STM32	

		microcontroller **SEMINAR**: Solving tasks using PWM time diagrams	
12	[1], Ch. 15, p.3-5; [2], Ch. 15, p.1-4;	**LECTURE:** Timer modes **LAB**- Configuring Timer of STM32 microcontrollers	
13	[2], Ch 21, p.1-6; [2],Ch. 24,p.1-4	**LECTURE:** Watchdogs and Random number generators (RNG) **LAB**- Generating PWM signals using a STM32 microcontrollers **SEMINAR**- Generating random values in microcontrollers	
14	[1],Ch.22, p.1,2; [2],Ch 27,p.1-6; [2],Ch 30,p.1-5;	**LECTURE:** Serial Communication Protocols in microprocessor and microcontroller systems **LAB**- Performing random number generation using STM32 microcontrollers	
15	[1],Ch 22,p.3,4; [2],Ch. 28,p.1-17;	**LECTURE:** Data transfer between sensors and microcontrollers **LAB**- Performing Data transfer between sensors and STM32 microcontrollers **SEMINAR**: Debugging	
16			Final exam

Recommended Sources

TEXTBOOK(S)

1. Yifeng Zhu. “Embedded systems with ARM Cortex-M microcontrollers in assembly language and C”, third edition, E-Man Press, 2018.
2. RM0008, Reference manual.
3. Muhammad Tahir and Kashif Javed. “ARM microprocessor systems : Cortex-M architecture, programming, and interfacing”, CRC Press, Taylor &Francis Group, 2017

Additional information will be distributed either electronically or delivered in printed forms.

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