Identification	**Subject (Code, title, credits)**	ETR680, Industrial electronics, 8 ECTS
	Department	Physics and Electronics
	Program	Graduate
	Term	Spring 2026
	Instructor	Nijat Hajiyev
	E-mail:	hajiyev.nijat@khazar.org
	Phone:	
	Classroom/hours	11 Mehseti str. (Neftchilar campus)
	Office hours	
Prerequisites	-	
Language	English	
Compulsory/ Elective	Compulsory	
Required textbooks and course materials	Textbooks: [1] - Power Electronics and Motor Drives: Advances and Trends, Bimal K. Bose, Elsevier, 2nd Edition, 2020. [2] - Fundamentals of industrial electronics, Bogdan M. Wilamowski and J. David Irwin, Taylor and Francis Group, second edition, 2018.	
Course description	This course introduces the fundamental principles of electrical circuits with an emphasis on both theoretical analysis and practical applications. Students study basic circuit elements, circuit analysis techniques, and the behavior of reactive components in AC and DC systems. The course integrates simulation tools and measurement methods to develop strong analytical and problem-solving skills applicable to real-world electrical systems.	
Course objectives	• To develop a solid understanding of industrial electronics systems, including power electronics, motor drives, sensors, and automation components. • To enable students to analyze and design power conversion circuits such as rectifiers, inverters, and DC–DC converters for industrial applications. • To introduce motor drive principles and control techniques, including PWM-based speed and torque control methods. • To build practical skills in using embedded controllers, industrial communication protocols, and sensor interfacing in real-world systems. • To enhance system-level thinking through simulation, testing, and integration of complete industrial electronics systems via a mini-project.	
Learning outcomes	By the end of the course, students will be able to: • Analyze and explain the operation of industrial electronic systems, including power semiconductor devices, power converters, and motor drive systems. • Design and evaluate basic power conversion circuits (AC–DC, DC–DC, DC–AC) and assess their performance using simulation tools such as MATLAB/Simulink and LTspice. • Apply control principles, including PWM and PID techniques, to motor drive and industrial control applications.	

<table>
<tr><td></td><td colspan="3">• Interface embedded controllers with sensors, actuators, and industrial communication protocols for real-world industrial systems.</td></tr>
<tr><td rowspan="4">Teaching methods</td><td colspan="2">Case analysis</td><td>x</td></tr>
<tr><td colspan="2">Group discussion</td><td>x</td></tr>
<tr><td colspan="2">Lecture</td><td>x</td></tr>
<tr><td colspan="2">Simulation</td><td>x</td></tr>
<tr><td rowspan="7">Evaluation Criteria</td><td>Methods</td><td>Date/deadlines</td><td>Percentage (%)</td></tr>
<tr><td>Midterm Exam</td><td></td><td>30</td></tr>
<tr><td>Attendance</td><td>At each lesson</td><td>5</td></tr>
<tr><td>Quiz</td><td>4 quizzes during the semester</td><td>20</td></tr>
<tr><td>Activity</td><td>At each lesson</td><td>5</td></tr>
<tr><td>Final Exam</td><td></td><td>40</td></tr>
<tr><td>Total</td><td></td><td>100</td></tr>
<tr><td>Policy</td><td colspan="3">▪ Preparation for class
The structure of this course makes your individual study and preparation outside the class extremely important. The lecture material will focus on the major points introduced in the text. Reading the assigned chapters and having some familiarity with them before class will greatly assist your understanding of the lecture. After the lecture, you should study your notes and work on relevant problems and cases from the end of the chapter and sample exam questions.
▪ Withdrawal (pass/fail)
This course strictly follows the grading policy of the School of Science and Engineering. Thus, a student is expected to achieve a mark of at least 60% to pass. In case of failure, he/she will be required to repeat the course the following term or year.
▪ Cheating/plagiarism
Cheating or other plagiarism during the Quizzes, Midterm, and Final Examinations will lead to paper cancellation. In this case, the student will automatically get zero (0) without consideration.
▪ Professional behavior guidelines
The students shall behave in a way to create a favorable academic and professional environment during class hours. Unauthorized discussions and unethical behavior are strictly prohibited.
▪ Attendance
Students who attend the whole classes will get 5 marks. for three absence student loses 1 mark.
▪ Quizzes
There will be 4 quizzes in the semester. The quizzes will be announced in the classroom two weeks before and will relate to classroom exercises.
▪ Activity
Students who will be active during discussion of past lessons will be awarded with 5 activity mark.</td></tr>
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Tentative Schedule			
Weeks	Date/Day	Topics	Reference to textbooks
1.		Introduction to Industrial Electronics Systems. motor drives, sensors, and industrial automation concepts.	[1] pp. 1-25 [2] pp. 1-30
2.		Power Semiconductor Devices. Diodes, thyristors, MOSFETs, IGBTs, and their operation in industrial circuits.	[1] pp. 27-85 [2] pp. 75-140
3.		DC–DC and AC–DC Conversion. Rectifiers, choppers, power factor correction, and voltage regulation basics.	[1] pp. 87–150 [2] pp. 151–190
4.		Quiz 1	
5.		AC–AC and DC–AC Conversion. Inverters, cycloconverters, PWM techniques, and industrial applications.	[1] pp. 191–305 [2] pp. 241–310
6.		Motor Fundamentals for Industrial Applications. DC, induction, PMSM, and BLDC motor principles; torque-speed characteristics.	[1] pp. 307–380 [2] pp. 381–450
7.		Motor Drive Systems and Control. Open-loop and closed-loop control, PWM control of motor speed and direction.	[1] pp. 381–470 [2] pp. 451–520
8.		Embedded Controllers in Industry. Microcontrollers (STM32, TI C2000), timers, PWM generation, interfacing with sensors and actuators. Quiz 2	[1] pp. 551–600 [2] pp. 601–670
9.		Midterm exam.	
10.		Industrial Communication Protocols. CAN, Modbus, EtherCAT, Profinet for data exchange and control systems.	[1] pp. 601–670 [2] pp. 731–800
11.		Sensors and Transducers. Position, speed, temperature, current, and voltage sensors; signal conditioning techniques.	[1] pp. 471–520 [2] pp. 521–600
12.		Quiz 3	
13.		Industrial Control Concepts. PID controllers, state-space basics, PLC principles, and safety considerations.	[1] pp. 601–650 [2] pp. 671–730
14.		Feedback and Power System Stability. Feedback loops, stability analysis, compensators, soft-start techniques, and protection circuits.	[1] pp. 430–470 [2] pp. 801–

		Quiz 4	860
15.		Simulation and Testing of Industrial Circuits. MATLAB/Simulink, PLECS, LTspice;	[1] pp. 691–750 [2] pp. 861–930
	TBC	Final exam	

This syllabus is a guide for the course and any modifications to it will be announced in advance.