University of Gdańsk

Subject card

Subject name and code	Elements of Circuit Theory, PG_00182651						
Field of study	Physics						
Date of commencement of studies	October 2026		Academic year of realisation of subject		2028/2029		
Education level	Bachelor's studies		Subject group		Obligatory subject group in the field of study Optional subject group Subject group related to scientific research in the field of study		
Mode of study	full-time studies		Mode of delivery		at the university		
Year of study	3		Language of instruction		Polish		
Semester of study	5		ECTS credits		3.0		
Learning profile	academic		Assessment form		credit		
Conducting unit							
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Tadeusz Leśniewski				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	15.0	0.0	0.0	0.0	30
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours		Self-study	SUM
	Number of study hours	30		0.0		45.0	75
Subject objectives	The aim of the course *Elements of Circuit Theory* is to introduce students to the fundamental laws and methods of analyzing direct and alternating current electrical circuits. The course develops the ability to apply mathematical tools (differential equations, complex numbers) to describe circuit phenomena and fosters practical skills in measurement and interpretation of experimental results. Special emphasis is placed on understanding the physical principles underlying circuit behavior and on highlighting connections with other areas of physics and applications in measuring instruments.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[FIZL3_U05] can apply the formalism of classical electrodynamics and Maxwell's equation to describe electric and magnetic fields in vacuum and in material media and in electrical circuits, and to classify material media according to the way they interact with an external electromagnetic field	The student can apply Kirchhoff's laws to the analysis of electrical circuits. The student knows and understands the physical quantities describing circuit elements: resistance, capacitance, inductance, electric flux, and magnetic flux. The student can relate inductance, capacitance, and resistance to, respectively: energy stored in the magnetic field, energy stored in the electric field, and energy dissipated as heat in the circuit. The student can relate material properties (resistivity, electric permittivity, magnetic permeability) to the parameters of circuit elements.	[SU3] text preparation/written work
	[FIZL3_U11] can use various application software packages to present results and analyze data	The student can process laboratory measurement results (e.g., RLC circuit characteristics) using a spreadsheet or other computational software. The student can present results in the form of tables, graphs, and a short analytical description.	[SU2] presentation/project/paper/ report [SU3] text preparation/written work
	[FIZL3_W13] knows measuring instruments, their construction and principle of operation as well as the use of simple electronic systems	The student knows the principle of operation and application of a voltmeter, ammeter, oscilloscope, and function generator. The student can use these instruments to measure the characteristics of simple circuits (DC and AC).	[SW2] presentation/project/paper/ report [SW3] text preparation/written work
	[FIZL3_W07] knows and understands electromagnetic phenomena, laws of electrodynamics and the consequences of Maxwell's equations	The student understands the relationship between Maxwell's equations and the circuit laws (Ohm's law, Kirchhoff's laws). The student can describe phenomena occurring in R, L, and C elements in steady-state and transient conditions.	[SW3] text preparation/written work
	[FIZL3_W01] has advanced knowledge of physical concepts, principles and theories, understands their historical development and significance not only for physics, but also for other exact and natural sciences and cognition of the world	The student knows the fundamental laws governing electrical circuits (Ohm's law, Kirchhoff's laws, Thevenin's and Norton's theorems) and understands their historical significance in the development of electrodynamics. The student can identify analogies between circuit theory and other areas of physics (e.g., mechanics of oscillations).	[SW3] text preparation/written work

Subject contents	1. Fundamentals • Basic electrical quantities: voltage, current, power, and energy. • Ohms law and Kirchhoffs laws. • Models of ideal elements: resistor, capacitor, inductor. • Voltage and current sources real models. • Material parameters in electrical circuits. 2. Direct Current (DC) Circuits • Basic configurations: series and parallel. • Basic analysis methods: mesh method, node method. • Equivalent circuits Thevenins and Nortons theorems. 3. Alternating Current (AC) Circuits • Phenomena in capacitors and inductors under alternating current. • Active and reactive resistance, impedance. • Resonance phenomena (series and parallel). 5. Fundamentals of Circuit Analysis Tools • Differential equations describing time-domain relationships. • Analysis in the domain of complex numbers. • Elements of nonlinear circuit theory (diodes). 6. Connections with Other Areas of Physics • Circuits as models of physical systems (e.g., analogy with mechanical oscillations). • The role of electrical circuits in measuring instruments and detectors. • Introduction to the generation of electromagnetic radiation.

<table>
<tr><td>Prerequisites and co-requisites</td><td colspan="3">Before starting the course, the student should:
• have basic knowledge of general physics,
• have knowledge of electricity and magnetism (completed as part of an introductory physics course),
• be familiar with the fundamentals of higher mathematics: differential and integral calculus, elements of linear algebra, complex numbers,
• be able to use basic computer tools (text editor, spreadsheet).</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="3"><table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>written assessment</td><td>51.0%</td><td>100.0%</td></tr></table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">S. Bolkowski, Podstawy elektrotechniki, WNT

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<tr><td>Supplementary literature</td><td colspan="2">C.K. Alexander, M.N.O. Sadiku, Fundamentals of Electric Circuits,

Thomas L. Floyd, David M. Buchla Principles of Electric Circuits, Conventional Current Version</td></tr>
<tr><td>eResources addresses</td><td colspan="2"></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="3">• Explain the difference between an ideal and a real voltage source.
• State Kirchhoffs laws and apply them to the analysis of a simple circuit.
• Determine the equivalent resistance of a set of resistors.
• Apply Thevenins theorem to simplify circuit analysis.
• Calculate the impedance of an RLC circuit in steady state.
• Explain the physical meaning of active and reactive power in AC circuits.
• Determine the conditions for resonance in series and parallel RLC circuits.
• Solve the differential equation describing the voltage in an RC circuit after switching on a DC source.
• Plot the currentvoltage characteristic of a diode based on laboratory measurements.
• Give the analogy between an RLC circuit and a mechanical oscillatory system.</td></tr>
<tr><td>Work placement</td><td colspan="3">Not applicable</td></tr>
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