GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Circuits and Signals, PG_00067424		
Field of study	Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2026/2027
Education level	first-cycle studies	Subject group	Obligatory subject group in the field of study 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	1	Language of instruction	Polish
Semester of study	2	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Signals and Systems -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Kamil Stawiarski	
	Teachers	dr inż. Kamil Stawiarski dr hab. inż. Iwona Kochańska mgr inż. Damian Kąkol mgr inż. Mariusz Rudnicki	

Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	0.0	0.0	0.0	60
	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	60	3.0	37.0	100

Subject objectives	The aim of the **Circuits and Signals** course is to introduce students to the fundamentals of electrical circuit analysis, modeling, and signal analysis techniques. The course covers the properties of linear and energy-storing elements, analysis of DC and AC circuits, power balance, the use of operational amplifiers and controlled sources. Students will acquire skills in applying classical and operator methods (Laplace transform, Fourier transform) to analyze dynamic circuits, determine transfer functions, and derive frequency response characteristics. The course also introduces the principles of signal filtering (passive and active filters), resonance circuits, and phasor methods for steady-state analysis of sinusoidal signals. The course prepares students to design, analyze, and interpret the behavior of electrical systems in engineering applications and provides a foundation for further education in electronics, automation, and telecommunications.

<table>
<tr><td rowspan="3">Learning outcomes</td><td>Course outcome</td><td>Subject outcome</td><td>Method of verification</td></tr>
<tr><td>[K6_U03] can design, according to required specifications, and make a simple device, facility, system or carry out a process, specific to the field of study, using suitable methods, techniques, tools and materials, following engineering standards and norms, applying technologies specific to the field of study and experience gained in the professional engineering environment</td><td>The student has knowledge and skills in analyzing, modeling, and designing basic electrical circuits and signal systems. Is able to select and apply appropriate engineering methods and tools to implement simple circuit and filtering tasks in accordance with relevant standards. Can interpret and verify analysis results based on practical and simulation experience.</td><td>[SU4] Assessment of ability to use methods and tools
[SU3] Assessment of ability to use knowledge gained from the subject</td></tr>
<tr><td>[K6_W03] knows and understands, to an advanced extent, the construction and operating principles of components and systems related to the field of study, including theories, methods and complex relationships between them and selected specific issues - appropriate for the curriculum</td><td>The student knows and understands the structure and principles of operation of electrical components and systems, as well as methods for circuit analysis in the time and frequency domains. Possesses knowledge of the complex relationships between circuit elements and the influence of signal parameters on system behavior. Understands theories and methods of signal analysis and filtering in engineering applications.</td><td>[SW2] Assessment of knowledge contained in presentation</td></tr>
<tr><td>Subject contents</td><td colspan="3">Course content – lecture
1. Introduction to electrical circuit theory.
2. Linear and nonlinear components characteristics and models.
3. Analysis of DC circuits using mesh and node methods.
4. Controlled sources and their application in circuit analysis.
5. Operational amplifiers models and basic configurations.
6. Power balance in DC circuits.
7. Energy-storing elements capacitors and inductors, dynamic characteristics.
8. Differential equations describing dynamic circuits.
9. Introduction to the Laplace transform and its properties.
10. Solving circuit equations using the Laplace transform.
11. Operator impedances of R, L, C components.
12. Transfer function definition and applications.
13. Methods for determining transfer functions in linear circuits.
14. Analysis of dynamic circuits with initial conditions.
15. Sinusoidal steady-state analysis concept of complex impedance.
16. Phasor method in AC steady-state analysis.
17. Active, reactive, and apparent power in AC circuits.
18. Maximum power transfer impedance matching principle.
19. Series and parallel resonant circuits resonance conditions.
20. Frequency characteristics of circuits Bode plots.
21. Introduction to passive RLC filters.
22. Low-pass, high-pass, band-pass, and band-stop filters.
23. Filter parameters: passband, attenuation, slope steepness.
24. Analog active filters basic operation and configurations.
25. Fourier transform analysis of periodic and non-periodic signals.
26. Signal spectrum definition and determination.
27. Effect of filtering on the spectrum of composite signals.
28. Application of computer simulations in circuit analysis.
29. Comparison of classical and operator methods in circuit analysis.
30. Practical design and analysis of simple filtering circuits.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Assessment methods and criteria</td><td>Subject passing criteria</td><td>Passing threshold</td><td>Percentage of the final grade</td></tr>
<tr><td>Written exam</td><td>51.0%</td><td>40.0%</td></tr>
<tr><td>Midterm colloquium</td><td>51.0%</td><td>60.0%</td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">J. David Irwin,R. Mark Nelms, Basic Engineering Circuit Analysis

J. Osiowski i J. Szabatin: Podstawy teorii obwodów, tom I, II i III. WNT Warszawa 1993 (tom I i tom II) i 1995 (tom III) i późniejsze wydania.

A. Leśnicki: Technika sygnałów analogowych, tom 1 i 2, Wydawnictwo Politechniki Gdańskiej, Gdańsk 2014.</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">No requirements</td></tr>
<tr><td>eResources addresses</td><td colspan="2"></td></tr>
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Example issues/ example questions/ tasks being completed	1. Explain the concept of a Thevenin equivalent circuit. For a given linear electrical network, determine the parameters of its Thevenin equivalent source, clearly naming each step of the procedure. Discuss possible methods for determining these parameters. 2. Provide the definition of a causal signal. For a given first-order circuit, determine its unit step and/or impulse response. 3. List the most important properties of the Laplace transform. Based on these properties alone without referring to the definition formulas demonstrate how to determine Laplace transforms for piecewise constant and piecewise linear waveforms. 4. Discuss the application of the phasor (frequency domain) analysis method in the analysis of AC circuits. For a selected RLC circuit, analytically determine the output signal. Explain how your procedure would change if the excitation were switched from a cosine function to a sine function, and vice versa. 5. State the definition of the spectrum of a periodic signal based on the components present in its Fourier series representation. Calculate and/or sketch the spectrum of a rectangular (square) wave.
Practical activites within the subject	Not applicable