**Nazwa przedmiotu:**

Electronic Principles

**Koordynator przedmiotu:**

Prof. dr hab. inż. Artur Przelaskowski

**Status przedmiotu:**

Obowiązkowy

**Poziom kształcenia:**

Studia II stopnia

**Program:**

Data Science

**Grupa przedmiotów:**

Współny

**Kod przedmiotu:**

1120-IN000-ISA-0112

**Semestr nominalny:**

1 / rok ak. 2021/2022

**Liczba punktów ECTS:**

4

**Liczba godzin pracy studenta związanych z osiągnięciem efektów uczenia się:**

1. godziny kontaktowe – 55 h; w tym
a) obecność na wykładach – 30 h
b) obecność na ćwiczeniach – 15 h
c) konsultacje – 10 h
2. praca własna studenta – 60 h; w tym
a) przygotowanie do ćwiczeń – 20 h
b) przygotowanie do sprawdzianów – 20 h
c) zapoznanie się z literaturą – 20 h
Razem 115 h, co odpowiada 4 pkt. ECTS

**Liczba punktów ECTS na zajęciach wymagających bezpośredniego udziału nauczycieli akademickich:**

1. obecność na wykładach – 30 h
2. obecność na ćwiczeniach – 15 h
3. konsultacje – 10 h
Razem 55 h, co odpowiada 2 pkt. ECTS

**Język prowadzenia zajęć:**

angielski

**Liczba punktów ECTS, którą student uzyskuje w ramach zajęć o charakterze praktycznym:**

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**Formy zajęć i ich wymiar w semestrze:**

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| --- | --- |
| Wykład: | 30h |
| Ćwiczenia: | 15h |
| Laboratorium: | 0h |
| Projekt: | 0h |
| Lekcje komputerowe: | 0h |

**Wymagania wstępne:**

It will be assumed that attendees will have a background (high school level) in mathematics and physics.

**Limit liczby studentów:**

Tutorial – the number of students in a group matches the limits defined by the Warsaw University of Technology

**Cel przedmiotu:**

The aim of the course is to present selected issues, relevant in terms of knowledge and skills, related to principles of electronics. Applied criteria of interests include in particular: a) the physical conditions of the flow of AC and DC electric current; b) understanding the rules to transmit electrical signals in electronic circuits and layouts; c) utility of elementary electronic devices in solving the problems of modern computer science. Students learn the principles of designing the circuit elements, counting distributions of currents and voltages, setting the conditions for matching layouts or determining the equivalent circuit. They learn methods for simplistic analysis of the circuits/layouts, e.g. using piecewise linear model to analyze DC circuits of semiconductor non-linear elements. Symbolic method is applied to analyze AC circuits, including simplified non-linear analysis of small signals. The expected learning outcomes are gaining synthetic, theoretical and pragmatic, knowledge related to fundamentals of electronics. This knowledge is useful in solving typical engineering problems related to real applications of electronics in computer science. The intended effects are also the following skills: - clarifying the role of passive and active components with linear or non-linear characteristics; presentation of fixed and adjustable elements, ideologically and realistically modeled circuits for the purpose of intended functionality, - understanding the principles of elementary DC and AC circuits, and the meaning of the placed components; cognition of layout design rules in order to achieve the intended results, - counting of simple circuits, DC and AC, including application of effective rules and theorems transforming and simplifying the circuits; the efficient use of the symbolic method and complex numbers (AC case), - using simplified models of nonlinear components to analyze devices, circuits and layouts, - determination of frequency responses, magnitude and phase, for filters and simple layouts, - adjusting the parameters of components and circuits to achieve the intended output effects of designed devices and layouts.

**Treści kształcenia:**

Topics of lectures: Introduction: electronics outline, division, historical outline, development trends, electronic IT support, the role of integration at the level of apparatus, programming, information processing. Physical bases of circuits: significant physical quantities and phenomena, signal measurements, power generation, elementary electrical circuits, resistivity and resistance - Ohm's law, calculation of the equivalent resistance of simple circuits - binary, tee, four-terminal, concept of voltage and current sources, problem of loading real sources, source equivalence. Counting circuits: Kirchhoff's laws, Thevenin and Norton rules, current and voltage dividers, superposition principle. Alternating signals: alternating current and voltage, harmonic signals, harmonic parameterization, time courses, variable energy generators. AC circuits: sinusoidal current sources, RLC circuits, characteristics of ideal and real elements, calculation of substitute quantities, in particular: resistors, their design, parameters, types, capacitors - the role of capacitance, constructions, types, phase shift mechanism, coils - inductance characteristics , phase shifts, energy charging and delivery. Counting variable circuits: symbolic method, phasor-to-waveform relationship, simplifying temporal representations, complex numbers and calculations, symbolic version of the respective principles and methods used for counting circuits, impedance and reactance concepts, AC power. Filters: impedance as a function of frequency, the concept of transmittance, signal processing, types of filters, frequency response, counting the amplitude and phase characteristics of selected filters, sequence of filters - matching problem, determining input and output impedances, sharpness of the responses, voltage divider compensation, resonance circuits - goodness, overvoltage. Diode: non-linear circuit elements (e.g. triacs, thyristors, hallotrons, varistors), diode characteristics, rectifying, characteristics of semiconductor elements, band model, intrinsic and doped semiconductors, p-n junction, forward and reverse polarization, depletion area, Shockley model, diode counting in circuits, photodiodes, LEDs, Zener diode and breakdown, low signal method, applications - stabilizers, limiters, power supplies etc. Transistor: bipolar principle of operation, circuit diagrams, power variants - operating point, transistor switch, transistor current/voltage characteristics, power limits, models with line segments, amplifiers, followers, field effect - operating principle, circuit diagrams and characteristics, applications - fast switches, amplifiers etc. Basic systems: differential and operational amplifiers, feedback, phase loops, adders, counters, comparators, differentiation and integration systems. Topics of tutorials: Usefulness of electronics in computer science: computer equipment, interfaces, system architecture, measurement and signal processing, device programming - SWOT analysis. Calculation of simple relationships regarding physical quantities (charge, current, energy, power, resistance), tasks for calculating power in resistive circuits, equivalent resistance, elementary measurements of physical quantities. Calculation of simple DC circuits: current distribution, voltage distribution, with current/voltage sources, determination of equivalent circuits, tasks using Ohm's, Kirchhoff's laws, Thevenin and Norton principles and superposition, calculation of voltage/current dividers. Analysis of RLC variable signals and circuits: parameterization of harmonic signals, instantaneous values, transients, phase shifts, equivalent impedance, instantaneous waveforms on switched L and C, transformations of complex numbers, use of the symbolic method to describe variable signals, representation conversions. Calculation of AC circuits: superposition of DC and AC sources, overvoltage on L/C in resonance, counting of transient filter characteristics, transmittance. Calculation and design of circuits with diodes and transistors: linear approximations, superposition problem, determining the transistor's operating point, designing the amplifier for given parameters, switches etc. Analysis of selected electronic circuits and devices: power supplies, operational amplifiers, complex filters.

**Metody oceny:**

The condition is to get at least 51 points/100 points. The 100 possible points consists of 20 points for activity, 30 points behind mid-term written test and 50pkt for the final written test. The final grade will be awarded according to the following scale (all the points earned during the term are taken into account):
From 51 to 60: grade 3.0.
From 61 to 70: grade 3.5.
From 71 to 80: grade 4.0.
From 81 to 90: grade 4.5.
From 91 to 100: grade 5.0.

**Egzamin:**

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**Literatura:**

1. C. A. Meyer, Basic Electronics. An Introduction to Electronics for Science Students, Carnegie Mellon University, 2006.
2. R. J. Smith, Circuits, Devices and Systems, John Wiley & Sons.
3. Chen, Wai-Kai (ed.), Electrical Engineering Handbook, 2005 Elsevier.
4. N. Kularatna: "Electronic Circuit Design, From Concept to Implementation", CRC Press.
5. Simulation software: LT Spice (http://www.linear.com/designtools/software/#Spice )

**Witryna www przedmiotu:**

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**Uwagi:**

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## Charakterystyki przedmiotowe

### Profil ogólnoakademicki - wiedza

**Charakterystyka W01:**

Has an elementary knowledge of electronics and telecommunication, need to understand digital techniques and functioning rules of modern computers as well as wireless networks

Weryfikacja:

written tests

**Powiązane charakterystyki kierunkowe:** DS2\_W12\*\*

**Powiązane charakterystyki obszarowe:**

### Profil ogólnoakademicki - umiejętności

**Charakterystyka U01:**

Can use the acquired knowledge of mathematics to create and use models of electronic components and layouts

Weryfikacja:

written tests, graded classroom activity

**Powiązane charakterystyki kierunkowe:**

**Powiązane charakterystyki obszarowe:**

**Charakterystyka U02:**

Can obtain information from literature and other reliable sources, to make their interpretations and draw conclusions

Weryfikacja:

written tests, graded classroom activity

**Powiązane charakterystyki kierunkowe:** DS2\_U09

**Powiązane charakterystyki obszarowe:**

**Charakterystyka U03:**

Is able to plan and carry out experiments, including measurements and computer simulations, and can interpret the results and draw conclusions

Weryfikacja:

written tests, graded classroom activity

**Powiązane charakterystyki kierunkowe:** DS2\_U13, DS2\_U14

**Powiązane charakterystyki obszarowe:**

**Charakterystyka U04:**

Is able to use analytical methods, numerical simulation and experimental studies to formulate and solve engineering tasks

Weryfikacja:

written tests, graded classroom activity

**Powiązane charakterystyki kierunkowe:** DS2\_U21\*\*

**Powiązane charakterystyki obszarowe:**

**Charakterystyka U05:**

speaks English in the area of basic issues of electronics

Weryfikacja:

written tests, graded classroom activity

**Powiązane charakterystyki kierunkowe:** DS2\_U15

**Powiązane charakterystyki obszarowe:**

### Profil ogólnoakademicki - kompetencje społeczne

**Charakterystyka K01:**

Can work independently, also can manage their time, make commitments and meet deadlines

Weryfikacja:

written tests, graded classroom activity

**Powiązane charakterystyki kierunkowe:** DS2\_K03

**Powiązane charakterystyki obszarowe:**