(faculty stamp)

COURSE DESCRIPTION

1. Course title: FUNDAMENTALS OF ELECTRIC CIRCUITS	**2. Course code: FEC**
3. Validity of course description: 2018/2019	
4. Level of studies: BSc programme	
5. Mode of studies: intramural studies	
6. Field of study: Informatics	
7. Profile of studies:	
8. Programme:	
9. Semester: 1,2	
10. Faculty teaching the course: Institute of Electronics, Rau3	
11. Course instructor: Damian Grzechca, PhD. DSc.	
12. Course classification:	
13. Course status: compulsory	
14. Language of instruction: English	
15. Pre-requisite qualifications: Course attendants are supposed to have general knowledge concerning mathematics (i.e. the ability to solve algebraic equations, operations on complex numbers, differentiation and integration of basic functions), physics (elementary concepts and laws such as the electrostatic field, familiarity with the basic electrical units, Ohm's law and Kirchhoff's laws).	
16. Course objectives: The main objective of the course is to provide basic and advanced knowledge concerning linear and nonlinear direct current (DC), time domain (s-domain), alternating current (AC) and transmission line circuits. During the course the students should develop the skills concerning the analysis methods of circuits in DC, time and frequency domains, know how to use simulate software in order to find the solution.	
17. Description of learning outcomes:	

Nr	Learning outcomes description	Method of assessment	Teaching methods	Learning outcomes reference code
1	Know fundamentals laws, theorems and principles of electric circuits (FEC1 and FEC2)	Assessment/Exam	Lectures/Classes	K1A_W05
2	Know analyses methods for linear electric circuits in DC, time (FEC1) and AC (FEC2) domains	Assessment/Exam	Lectures, Classes	K1A_W05
3	Can analyze simple electric circuits in DC, time (FEC1), and AC (FEC2) domains	Exam	Lectures, Classes	K1A_U03
4	Can analyze electric circuits with the use of electric circuit simulation software	Exam	Lecture	K1A_U03
5	Have the ability to self-education with use of e-teaching materials	Exam	Lecture, Classes	K1A_U09
6	Can read and understand problems (text and description) in the field of	Assessment/exam	Lecture	K1A_U10

	electric circuits			

18. **Teaching modes and hours**
Lecture / BA /MA Seminar / Class / Project / Laboratory
45 h (Lecture), 30 h (Class);

19. Syllabus description:

Semester 1. Lectures:

1. Introduction to circuit theory, circuit variables - basic terms and definitions, classification of electric circuit problems, circuit elements: resistor, sources. Passive/active sign convention, circuit diagram, ideal voltmeter/ammeter.
2. Passive two-terminal elements: resistor (Ohm'a law), equivalent resistance, voltmeter, ammeter, practical voltage and current sources, Kirchhoff's laws, voltage/current dividers
3. Superposition principle. Energy and power conservation principle, two-terminal subcircuit, Thevenin's/Norton's theorem, passive two-terminal subcircuit, series connection of resistors. Active two-terminal subcircuit. Maximum power transfer theorem.
4. Transfer function. Superposition principle. Transfer function. One-dimensional case, multi-dimensional case. Separation principle (source substitution theorem).
5. Multi-terminal elements. Element description – conductance matrix. Passive multi-terminal element. Two-terminal element (one-port). Three-terminal element. Two-port. Active multi-terminal element. Other matrices of multi-terminal element. Analysis of circuits with multi-terminal element(s).
6. Analysis of complex circuits, node voltage (nodal) analysis.
7. Analysis of nonlinear circuits. Graphical analysis. Series connection of elements. Parallel connection of elements. Single-loop circuit. Circuit with one nonlinear element. Analysis based on PWL approximation.
8. Transient analysis. Kirchhoff's laws and passive element laws. Kirchhoff's laws. Passive element laws: Resistor, capacitor, coil (inductor). Passive elements – summary. Energy stored elements behavior – current voltage relationship. Fundamental facts related to simple RC and RL circuits. Capacitor/coil time domain and s-domain models.
9. Transient analysis in the 1st order circuits – zero and non-zero initial conditions – boundary values based method. Characteristic circuit values and time domain responses. Practical step, practical pulse.
10. 1st order circuit – s-domain method. Laplace transform method, capacitor/coil model. Dictionary between s-domain and time domain.
11. Transient analysis in circuits with arbitrary excitation. Transfer function – properties and selected examples. Properties. Transfer functions of selected circuits. Integrator. Differentiator.
12. 2nd order circuit – s-domain method. Heaviside formula. Natural response. Complete response: natural response + forced response. Higher order circuits.
13. **Introduction to computer added simulation software - PSpice tutorial – DC & time domain examples**.
14. Dependent (controlled) elements. Arbitrary dependent element – description. Controlled sources – description. Use of controlled sources to element modeling.
15. Transistor. Operational amplifier. Arbitrary three-terminal or two-port element. Analysis of circuits containing controlled sources.

Semester 1. Classes:

1. Simple electric circuits: application of Ohm's law and Kirchhoff's laws; equivalent resistance. Examples of voltage and current dividers, current – voltage relationship for passive elements (resistors/receivers) and active elements (voltage and current sources). Ideal/real voltmeter and ammeter.
2. Passive two-terminal elements (current-voltage characteristics): resistor (equivalent resistance), voltmeter, ammeter. Ideal and real sources (current-voltage characteristic). Simple electric circuits (continuation), e.g. voltage adder. Power dissipation in electric circuits – energy and power preservation principles.
3. Superposition principle. Circuit with two/three sources, incremental analysis, power dissipation using superposition principle.
4. Equivalent active elements (voltage-current arrows and comparison with sources): Thevenin's and Norton's theorems. Calculation of equivalent active elements by: circuit approach, measurements approach and characteristic approach. Maximum power transfer condition.
5. Nodal analysis method – general approach, exceptions – balance of power.
6. Transient analysis in the first order circuits in s-domain. Zero and non-zero initial conditions – part 1.
7. Transient analysis in the first order circuits in s-domain. Zero and non-zero initial conditions – part 2.
8. **Computer assessment – test 1**

Semester 2. Lectures:

1. AC steady-state analysis. Alternating current – RMS value, phasor notation. Complex numbers.
2. Phasor analysis. Kirchhoff's laws. Current-voltage relationship: resistor, inductor, capacitor. General two-terminal phasor circuit, phasor impedance.
3. AC steady-state analysis. Application of nodal analysis. AC steady-state power. Measures of power. Instantaneous power. Average or real power. Apparent power. Reactive power. Complex power. Maximum power transfer theorem.
4. Frequency characteristics of two-terminal subcircuit. Ideal elements – summary (Resistor. Inductor. Capacitor). Practical coil and practical capacitor characteristics, their impedances and behaviors.
5. Simple electric filters RC, RL. Transfer function in frequency domain. Amplitude and phase characteristics. Bode Plot (log-log characteristic).
6. Resonant circuits: series-resonant circuit RLC, parallel-resonant circuit RLC. Complex-resonant circuit. Resonant filters. Transfer function

approach - frequency response. Bode (logarithmic) plot. Filters. Low-pass filter – LPF. High-pass filter – HPF. Band-pass filter – BPF. Band-stop filter – BSF.
7. Circuits with distributed parameters. Transient analysis in transmission line.
8. **Computer added simulation software - examples**.

Semester 2. Classes:

1. Transient analysis in the first order circuits with zero and non-zero initial condition (reminder). Integrator, differentiator – operation amplifier examples.
2. AC domain circuits. Phasors. Phasor diagrams. RMS value, voltmeter/ammeter indications. Current-voltage relationship for resistor, capacitor and coil.
3. Power in AC domain circuits. Power balance,
4. Frequency response of AC circuits. Simple filters: RC, RL – linear and logarithmic characteristics.
5. Resonant circuits and resonant filters. Linear and logarithmic characteristics.
6. Transmission line. Time domain analysis.
7. Preparation for assessment test – exemplary problems.
8. **Computer assessment – test 2.**

20. Examination: Yes (exam – sem.2)

21. Primary sources:

1. Richard C. Dorf, James A. Svoboda, Introduction to electric circuits, john Wiley & Sons, Inc. (8th edition, 2009)
2. Rutkowski J., Circuit Theory, Wydawnictwo Politechniki Śląskiej, Gliwice 2006.
3. Allan H. Robbins and Wilhelm C Miller, Circuit Analysis: Theory and Practice, Delmar Cengage Learning; 4 edition (July 19, 2006)
4. http://platforma.polsl.pl/rau3

22. Secondary sources:

1. John M. Santiago Jr., Circuit analysis for Dummies, Publisher: For Dummies; 1 edition (April 22, 2013)
2. John R. O'Malley, Basic Circuit analysis, McGraw-Hill Education; 2 edition (February 17, 2011)

23. Total workload required to achieve learning outcomes

Lp.	Teaching mode :	Contact hours / Student workload hours
1	Lecture	45/30
2	Classes	30/30
3	Laboratory	0/0
4	Project	0/0
5	BA/ MA Seminar	0/0
6	Other	0/15
	Total number of hours	75/75

24. Total hours: 150

25. Number of ECTS credits: 8

26. Number of ECTS credits allocated for contact hours: 3

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 0

28. Comments:

Approved:

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(date, Instructor's signature) (date, the Director of the Faculty Unit signature)