(*faculty stamp*)

COURSE DESCRIPTION

1. Course title: CIRCUIT THEORY	**2. Course code: CT**
3. Validity of course description: 2012/2013	
4. Level of studies: BSc programme	
5. Mode of studies: intramural studies	
6. Field of study: Control, Electronic, and Information Engineering	RAU
7. Profile of studies:	
8. Programme:	
9. Semester: 1, 2	
10. Faculty teaching the course: Institute of electronics, RAu3	
11. Course instructor: prof. dr hab. inż. J. Rutkowski, dr hab. inż. D. Grzechca	
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 (including 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).

16. Course objectives:

CT1: The main objective of the course is to provide the students with basic and advanced knowledge concerning linear and nonlinear direct current (DC) circuits. During the course the students should develop skills concerning the analysis methods of these circuits.
CT2: The main objective of the course is to provide the students with basic and advanced knowledge concerning alternating current (AC) circuits and time domain circuits with aperiodic stimulus: RLC circuits and transmission line. The students should understand differences between these circuits and know how to analyze them in both time and frequency domain.

17. Description of learning outcomes:

Nr	Learning outcomes description	Method of assessment	Teaching methods	Learning outcomes reference code
W1	A student is familiar with basic terms, concepts and laws of electrical circuits (CT1 & CT2)	Exam	Lecture	K1A_W05
W2	A student knows fundamental methods of analysis of DC circuits (CT1)	Assessment test	Lecture	K1A_W05
W3	A student knows fundamental methods of analysis of AC circuits and methods of transient analysis in RLC circuits and transmission line (CT1 & CT2)	Exam	Lecture	K1A_W05
W4	A student is able to solve problems by means of electric circuit simulator (CT1 & CT2)	Exam	Lecture/Laboratory	K1A_W17
U1	A student has ability to Self-Directed Learning, readiness to adapt Flip-Teaching (CT1 & CT2)	Exam	Lecture	K1A_U05
U2	A student is able to analyze DC circuits (CT1)	Assessment test	Classes	K1A-U13
U3	A student is able to analyze AC circuits, perform transient analysis of RLC circuits and transmission line (CT1 & CT2)	Exam	Classes	K1A-U13
U4	A student knows how to measure basic electric quantities, transient and frequency response of RLC circuits (CT2)	Laboratory assessment test	Laboratory	K1A_U18 K1A_U20

18. Teaching modes and hours

Lecture / BA /MA Seminar / Class / Project / Laboratory

Sem. 1: 30 h (Lecture), 30 h (Classes); Sem. 2: 30 h (Lecture), 15 h (Classes), 15 h (Laboratory)

19. Syllabus description:

Semester 1 :

Lecture:

1. Introduction to circuit theory, circuit variables - basic terms and definitions, classification of circuit theory problems, dc analysis, circuit elements, classification.
2. Passive two-terminal elements: resistor, voltmeter, ammeter, active two-terminal elements, voltage source, current source, circuit diagram and Kirchhoff's laws, circuit diagram, Kirchhoff's laws. Energy and power conservation principle.
3. Analysis of complex circuits: node voltage (nodal) analysis, PSpice simulations
4. Passive and active two-terminal circuit: Equivalent resistance, voltage and current dividers, Thevenin's/Norton's theorems. Practical sources.
5. Separation principle (source substitution theorem). Maximum power transfer theorem.
6. Transfer function. Superposition principle.
7. Multi-terminal elements. Element description – conductance matrix. Analysis of circuits with multi-terminal element(s).
8. Controlled sources – description. Use of controlled sources to element modeling. Analysis of circuits containing controlled sources. Design tolerances: worst case and sensitivity analysis.
9. Analysis of nonlinear circuits. Graphical analysis. Series connection of elements. Parallel connection of elements. Single-loop circuit.
10. Analysis based on PWL approximation. Analysis based on Newton-Raphson iteration scheme. Network analogies – magnetic circuits.
11. Introduction to Transient analysis. Kirchhoff's laws and passive (RLC) element laws in time domain and s-domain.
12. Transient analysis in circuits with step excitation. Forced response of the 1st order circuit: s-domain method.
13. Forced and complete response of the 1st order circuit: boundary values based method, PSpice simulations.

Classes:

1. Current, Voltage, Power, Energy.
2. Simple linear circuit analysis. Application of the Ohm's and Kirchhoff's laws – on-diagram analysis.
3. Circuits with ideal and real ammeter and/or voltmeter. Power balance.
4. Nodal analysis. PSpice simulation.
5. Equivalent resistance, Thevenin's and Norton's theorems. Practical sources.
6. Separation principle. Maximum power transfer theorem.
7. Superposition principle. Incremental analysis.
8. Multi-terminal elements. Controlled sources.
9. Nonlinear circuit analysis – graphical method.
10. Nonlinear circuit analysis – PWL approximation based method.
11. Assessment test
12. Element (RLC) equations in time domain.
13. Forced response of the 1st order circuit: s-domain method.

Semester 2:

Lecture:

1. Forced response of the 2nd order circuit. Forced response of the 3rd and 4th order circuit – PSpice simulation.
2. Natural response of the 2nd order circuit.
3. Laplace Transfer Function – properties and selected examples. Integrator and Differentiator, ideal and practical (RC).
4. Transient analysis in circuits with arbitrary excitation: pulse, practical step.
5. Introduction to AC steady-state analysis. Alternating current: RMS value, phasor notation. Kirchhoff's laws and Element laws: (resistor, inductor, capacitor) in phasor domain. General two-terminal phasor circuit, phasor impedance.
6. Phasor analysis - PSpice simulations. AC steady-state power and energy: instantaneous power, average or real power, apparent power, reactive power, complex power. Maximum power transfer.
7. Frequency characteristics of two-terminal circuit: Practical coil and practical capacitor. Resonant circuits. Series-resonant circuit RLC. Parallel-resonant circuit RLC. Complex-resonant circuit.
8. Transfer function approach - frequency response. Bode (logarithmic) plot.
9. Filters: Low-pass filter, High-pass filter, Band-pass filter, Band-stop filter.
10. Mutual inductance and transformers. Mutual inductance – basic transformer. Ideal transformer. Practical iron-core transformer.
11. Three-phase circuits. Delta-delta and wye-delta systems. Power in three-phase systems. Electrical safety
12. Circuits with distributed parameters - Introduction. Matched line.
13. Transient analysis in not-matched transmission line.

Classes:

1. Complete response of the 1st order circuit – boundary values based method. PSpice simulation of transient state.
2. Forced and natural response of the 2nd order circuit.
3. Integrator & differentiator. Transients with arbitrary aperiodic stimulus (pulse).
4. AC domain circuits. Phasor analysis. Power in AC domain circuits.
5. Frequency characteristic of two-port circuit. Resonant circuits
6. Frequency response of two-port circuit. Bode plot. Filters.
7. Time domain analysis of not-matched transmission line.

Laboratory:

1. Introduction to laboratory and to work with oscilloscope
2. Transient in first order circuits with zero initial conditions switched on a DC source
3. Transient in higher order circuits with zero initial conditions switched on a DC source
4. Transient in circuits with non-zero initial conditions
5. Resonance and frequency response
6. Transmission lines

20. Assessments: Semester 1: written assessment test; Semester 2: Examination - written test; Laboratory: positive grade required for each laboratory exercise.

21. Primary sources:

1. Rutkowski J., Circuit Theory, Wydawnictwo Politechniki Śląskiej, Gliwice 2006.
2. Allan H. Robbins and Wilhelm C Miller, Circuit Analysis: Theory and Practice, Delmar Cengage Learning; 4 edition (July 19, 2006)
3. http://platforma.polsl.pl/rau3

22. Secondary sources:

1. Chua L.O., Lin P.M., Komputerowa analiza układów elektronicznych, WNT, Warszawa 1981.
2. Osowski S., Siwek K., Śmiałek M., Teoria Obwodów, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2006.
3. Osiowski J., Szabatin J., Podstawy teorii obwodów, WNT, Warszawa 1993.

23. Total workload required to achieve learning outcomes

Lp.	Teaching mode :	Contact hours / Student workload hours
1	Lecture	60/30
2	Classes	45/55
3	Laboratory	15/60
4	Project	0/0
5	BA/ MA Seminar	0/0
6	Other	20/35
	Total number of hours	140/180

24. Total hours: 320

25. Number of ECTS credits: 11

26. Number of ECTS credits allocated for contact hours: 5

27. Number of ECTS credits allocated for in-practice hours (laboratory, classes): 2x3=6

26. Comments: