AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Nazwa modułu:	Analogue Electronic Circuits 1
Rok akademicki:	2014/2015
Kod:	IES-1-306-s
Punkty ECTS:	7
Wydział:	Informatyki, Elektroniki i Telekomunikacji
Kierunek:	Electronics and Telecommunications
Specjalność:	—
Poziom studiów:	Studia I stopnia
Forma i tryb studiów:	Stacjonarne
Język wykładowy:	Angielski
Profil kształcenia:	Ogólnoakademicki (A)
Semestr:	3
Strona www:	—
Osoba odpowiedzialna:	dr hab. inż. Machowski Witold (witold.machowski@agh.edu.pl)
Osoby prowadzące:	dr hab. inż. Machowski Witold (witold.machowski@agh.edu.pl)

Opis efektów kształcenia dla modułu zajęć

Kod EKM	Student, który zaliczył moduł zajęć wie/umie/potrafi	Powiązania z EKK	Sposób weryfikacji efektów kształcenia (forma zaliczeń)
Wiedza			
M_W001	Student knows basic bipolar and CMOS circuit implementations of most important functional blocks	ES1A_W21, ES1A_W16	Egzamin
M_W002	Student knows principles of analysis and design of analog electronic circuits	ES1A_W15, ES1A_W12	Egzamin
Umiejętności			
M_U001	Student can design analog electronic circuit using appropriate methods, techniques and tools.	ES1A_U16	Kolokwium
M_U002	Student can utilize circuit implementations of analog blocks with taking into account performance and non-technical (eg. costs) issues.	ES1A_U09	Kolokwium
M_U003	Student is able to formulate design specification for simple electronic systems and subsequently verify it.	ES1A_U15	Kolokwium
Kompetencje społeczne			
M_K001	Student understands the necessity and knows possibilities of lifelong learning and improving the professional competencies and qualifications	ES1A_K01	Kolokwium

M_K002	Student is aware of the importance of non-technical aspects and consequences of his/her activity as an electronic engineer including responsibility for possible impact on environment	ES1A_K02	Kolokwium

Matryca efektów kształcenia w odniesieniu do form zajęć

Kod EKM	Student, który zaliczył moduł zajęć wie/umie/potrafi	Forma zajęć										
		Wykład	Ćwiczenia audytoryjne	Ćwiczenia laboratoryjne	Ćwiczenia projektowe	Konwersatorium	Zajęcia seminaryjne	Zajęcia praktyczne	Zajęcia terenowe	Zajęcia warsztatowe	Inne	E-learning
Wiedza												
M_W001	Student knows basic bipolar and CMOS circuit implementations of most important functional blocks	+	+	-	-	-	-	-	-	-	-	-
M_W002	Student knows principles of analysis and design of analog electronic circuits	+	+	-	-	-	-	-	-	-	-	-
Umiejętności												
M_U001	Student can design analog electronic circuit using appropriate methods, techniques and tools.	+	+	+	-	-	-	-	-	-	-	-
M_U002	Student can utilize circuit implementations of analog blocks with taking into account performance and non-technical (eg. costs) issues.	+	+	+	-	-	-	-	-	-	-	-
M_U003	Student is able to formulate design specification for simple electronic systems and subsequently verify it.	+	+	+	-	-	-	-	-	-	-	-
Kompetencje społeczne												
M_K001	Student understands the necessity and knows possibilities of lifelong learning and improving the professional competencies and qualifications	+	+	+	-	-	-	-	-	-	-	-
M_K002	Student is aware of the importance of non-technical aspects and consequences of his/her activity as an electronic engineer including responsibility for possible impact on environment	+	+	+	-	-	-	-	-	-	-	-

Treść modułu zajęć (program wykładów i pozostałych zajęć)

Wykład

Module comprises lectures (28 hr) discussion class (30 hr) and laboratory exercises (28 hr) Lectures

1. Electronics and microelectronics. Filters, amplifiers and other two-ports. Basic classes of amplifiers. Input and output impedance. OpAmp as a Black Box. Analysis of linear applications with OpAmps – inverting and non-inverting configuration.
2. Frequency response of simple RC circuits. Behavioral description of open loop OpAmp's gain. Gain-bandwidth exchange in OpAmp circuits. Other OpAmp non-idealities and their impact on application performance. OpAmp based differentiator and integrator. Instrumental amplifiers.
3. Large and small-signal models of BJT. Relationship between collector current and small signal parameters. Impedance seen from base, collector and emmiter. Roboust BJT biasing in discrete and integrated technology. BJT amplifiers configurations – OE OB and emmiter follower. Benchmark parameters for different configurations.
4. Frequency response of transistor circuits. Miller effect.Intristic gain and fT.
5. MOSFET models for hand calculations. Body effect. Short channel MOSFETS. MOSFET biasing and amplifier configurations – CS, CG and CD.
6. Active biasing and load in bipolar and CMOS integrated circuits. Current sources/sinks and mirrors. Cascode configuration and its advantages. Folded cascode.
7. Feedback topologies. Sensing and return schemas. Feedback's impact on amplifier parameters. Practical feedback circuit examples. Stability issues degenerative and regenerative feedback.
8. DC amplifiers. Long tail bipolar and MOSFET pair. Common mode and differential signals. Transfer curves for diffpair.
Small signal analysis of differential ammlifiers. CMRR and PSRR. Internal structure of OpAmp. Frequency compensation. Slew rate. Rail-to-rail amplifiers.
9. Active filters. Types of filters. Approximation, implementation and filter synthesis. Integrators, biquads.
Discrete time analog circuits – SC and SI filters.
10. Noise in electronic circuits. Noise origin in electronic devices. Noise parameters. Noise optimization and reduction. Interference noise and shielding.
11. Output stages and power amplifiers. Thermal issues in electronics. Safe operation area. Overheat protection. Thermal resistance.
12. Rectifiers and voltage regulators. Parametric stabilizers. Voltage regulators topology. Short protection and foldback. Pulse regulators and DC voltage converters.

Ćwiczenia laboratoryjne

Laboratory class
The main philosophy of this lab is "learning by doing".
Students work in teams and assembly practical circuits using solderless protoboards and THT elements/devices.
Subsequent themes are described more detailedly in lab manuals posted on the course webpage.
1. Introductory exercises. Safety rules in the laboratory. Getting familiar with laboratory equippment. Simple experiments with RC cicruics stimulated with sine and pulse waveforms.
2. OpAmp based circuits (inverting, noninverting, adder etc.)
3. OpAmp applications – students realize own project approved by the laboratory instructor.
4. BJT – biasing circuits

5. Single BJT amplifiers
6. Single CMOS amplifiers
7. BJT/CMOS differential pair
8. Voltage regulators
9. Final practical test – each student is expected to practically perform part of the lab exercise previously made with his/her team

Ćwiczenia audytoryjne

Discussion class:
1. Analysis and design of linear OpAmp applications.
2. Frequency response of OpAmp circuits. Stability of feedback circuits. Phase/gain margin concepts.
3. Bias calulations based on large signal models. Bias current sensitivity. Role of approximate calculations. Small-signal operation concept and models.
4. Analysis of small-signal parameters for different types of amplifier configurations.
5. Design procedures for amplifiers with desired gain and input/output impedance. Trade-offs in electronic circuit design. Impact of elements’ tolerances on performance.
6. Feedback circuit analysis. Basic topologiers. Intuitive sensing and return mechanism recognition.
7. Analysis of differential pairs. Active loads. Designing current mirrors.
8. Analysis and design of voltage regulators

Sposób obliczania oceny końcowej

Final grade will be issued after successful assesment of both discussion and laboratory class as well as passing the final exam. The final grade is weighted sum of auditory class assesment (20%), lab class assesment (20%), final exam (50%) and lecture quizzes (10%).

Wymagania wstępne i dodatkowe

Background in mathematics (calculus, matrix algebra, complex numbers), circuit theory, semiconductor devices. Basic laboratory skills – multimeter, oscilloscope, signal generator use.

Zalecana literatura i pomoce naukowe

B. Razavi Fundamentals of Microelectronics, Willey, 2008
A. Sedra, K.C. Smith, Microelectronic Circuits, Oxford UP 2010
R. Jaeger, T. Blalock, Microelectronic Circuit Design,McGraw Hill 2003
A. Agarwal, J.H Lang, Foundations of Analog and Digital Electronic Circuits, Elsevier 2005

Publikacje naukowe osób prowadzących zajęcia związane z tematyką modułu

W. Machowski “Niskonapięciowe układy analogowe bazujące na inwerterach CMOS w scalonych systemach VLSI” monografia habilitacyjna, Wydawnictwa AGH, 2012

Informacje dodatkowe

Brak

Nakład pracy studenta (bilans punktów ECTS)

Forma aktywności studenta	Obciążenie studenta
Udział w wykładach	28 godz
Samodzielne studiowanie tematyki zajęć	46 godz
Udział w ćwiczeniach laboratoryjnych	28 godz
Przygotowanie do zajęć	45 godz
Udział w ćwiczeniach audytoryjnych	28 godz
Sumaryczne obciążenie pracą studenta	175 godz
Punkty ECTS za moduł	7 ECTS