RTU Course "Power Electronics"

33000 Faculty of Computer Science, Information Technology and Energy

General data

Code	EEP344
Course title	Power Electronics
Course status in the programme	Compulsory/Courses of Limited Choice
Responsible instructor	Iļja Galkins
Academic staff	Alvis Sokolovs Inna Buņiņa Anastasija Žiravecka Genadijs Zaļeskis Agris Treimanis
Volume of the course: parts and credits points	1 part, 4.5 credits
Language of instruction	LV, EN
Annotation	The study course deals with power electronic converters and their elements. The most important objects of the study course are: general definitions and mathematical tools of power electronics, one-cycle and multi-cycle DC/DC converters, diode and thyristor rectifiers, autonomous inverters and some specific converters. The study course is concentrated on calculation of parameters of the power converters, choice of their passive elements and semiconductor switches, as well as on the cooling and protection of these switches. The study course includes special lectures devoted to development of the power converter utilizing the corresponding modern integrated circuits. The practical part of the study course includes numerically solved exercises, exercises of simulation of the power converters, laboratory exercises. The most active students are provided with opportunity to design, build and test one of the studied power converters utilizing one of the available integrated circuits.
Goals and objectives of the course in terms of competences and skills	The aim of the study course is to introduce to power electronic converters, as well as to analysis of their operation and parameters. The tasks of the study course: 1)To introduce to the topologies of power electronic converters; 2)To give and advance the abilities and skills of their analysis; 3)To introduce how to choose a converter for a particular application and calculate its parameters; 4)To introduce how choose passive components and semiconductor switches as well as their protection and cooling elements for the converter.
Structure and tasks of independent studies	Unassisted work of the students is concluded of typical (obligatory) and special (optional) calculation exercises, simulation exercises, laboratory works and optional practical implementation of the studied converters. All necessary theoretical background for the calculations, simulation, labs and practice can be obtained during the corresponding lectures and/or from the recommended literature.
Recommended literature	Obligātā/Obligatory: 1) Ivars Raņķis „Energoelektronika", otrais atkārtotais izdevums, ISBN 9984-32-378-1, RTU izdevniecība, Rīga, 2004. g. 2) Ivars Raņķis, Anastasija Žiravecka, „Electronics (Short Synopsys of Lectures)" (angļu valodā), ISBN 9984-32-798-2, RTU izdevniecība, Rīga, 2005. g. 3) Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics: Converters, Applications and Design (second edition)", ISBN 0-471-30576-6, Publishing house "John Wiley & Sons", 1996. Papildu/Additional: 4) R. Ramshaw and D Schuurman, "PSpice – Simulation of Power Electronics Circuits", ISBN 0-412-75140-2, Publishing house "Chapman & Hall", 1997. 5) Barry Wayne Williams, "Power Electronics: Devices, Drivers, Applications, and Passive Components", http://www.eee.strath.ac.uk/~bwwilliams/book.htm 6) Johann W. Kolar, Interactive Examples for "Introductory Course on Power Electronics", http://www.ipes.ethz.ch/ 7) PSpice student version and documents, http://www.electronics-lab.com/downloads/schematic/013/
Course prerequisites	Basic knowledge of mathematics in the field of differential, integral calculus and Fourier transformation (analysis of harmonics). Basic knowledge of physics in the field of semiconductors and magnetic theory. Knowledge of theory of electrical engineering in the field of transient processes. Skills of simulation of electrical circuits with MATLAB and PSpice software.

Course contents

Content	Full- and part-time intramural studies		Part time extramural studies	
	Contact Hours	Indep. work	Contact Hours	Indep. work
Lecture (L): Pulse mode vs. active mode. Semiconductor switches: voltages, currents, frequency, control and assignments.	2	3	1	4
L: Definition of instantaneous, average and root mean square values, active and full power, efficiency and power factor.	3	2	1	4

L: Sinusoidal voltage and currents. Instantaneous, active, reactive and full power with sinusoidal signals.	2	3	1	4
L: Non-sinusoidal voltage and currents. Harmonic distortion. Power and power factor with non-sinusoidal signals.	3	2	1	4
Practice (P): Calculation of harmonic distortion factor for predefined signal.	2	3	1	4
P: Quasi-stationary mode of operation. Calculation of voltage across a capacitor for known current of the capacitor.	3	2	1	4
L: Non-idealities of power switches. Static and switching losses of transistors and diodes. Cooling.	2	3	1	4
P: Calculation of the static and switching losses of a chopper. Calculation of temperature and choice of heatsink.	3	2	1	4
L: Protection of switches, their series and parallel connection. Minimization of parasitic parameters of converters.	2	3	1	4
L: Basic design principles of magnetic elements: defining configurations, calculation and choice of cores and windings.	3	2	1	4
L: One-cycle DC/DC converters: schematics, voltage and current across their coil, output voltage in continuous mode.	2	3	1	4
L: Parameters and choice of switches for 1-cycle DC/DC. Parameters of output capacitor and its choice. Input current.	3	2	1	4
P: Calculation of parameters and choice of elements (switches, capacitor and coil) of 1-cycle DC/DC converters.	2	3	1	4
L: Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of flyback converters.	3	2	1	4
Laboratory work: Open loop and feedback operation of one-cycle DC/DC converters in continuous and discontinuous mode.	2	3	1	4
L: Half/full bridge DC/DC converters. Parameters of input/output switches, transformer and coil. Autonomous inverters.	3	2	1	4
L: Integrated solutions for DC/DC converters. Operation of integrated circuits (IC) TOP250, VIPer28, IRS2541 un CA1524.	2	3	1	4
L: Parameters of rectifiers and operation with different load. Schematics, operation and parameters of diode rectifiers.	3	2	1	4
P: Calculation of parameters of 3-phase neutral-point and bridge diode rectifiers at non-symmetrical input.	2	3	1	4
Operation and parameters of thyristor rectifiers. Inverter mode of operation and its conditions.	3	2	1	4
P: Calculation of parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-symmetrical input.	2	3	1	4
L: Operation of diode and thyristor rectifiers at non-zero input inductance.	3	2	1	4
L: Improvement of rectifiers utilizing pulse mode converters. Power factor corrector based on MC34262.	2	3	1	4
Laboratory work: Operation of diode and thyristor rectifiers.	3	2	1	4
Total:	60	60	24	96

Learning outcomes and assessment

Learning outcomes	Assessment methods
Able to recognize a particular power electronics converter and explain its operation and features.	Exam.
Able to formulate requirements for the choice of power converter for particular application.	Exam.
Knows how to calculate parameters of power converters	Exam.
Knows how to choose power semiconductor switches, their protection and cooling elements.	Exam.
Able to simulate the converters.	Exam.

Evaluation criteria of study results

Criterion	%
Exam	100
Total:	100

Study subject structure

Part	CP	Hours			Tests		
		Lectures	Practical	Lab.	Test	Exam	Work
1.	4.5	3.0	0.0	0.0		*	