

## 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	IĮja Galkins
Academic staff	Alvis Sokolovs Inna Buņina 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 intramura		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

ignals.  Non-sinusoidal voltage and currents. Harmonic distortion. Power and power factor with non- inusoidal signals.  Non-sinusoidal voltage and currents. Harmonic distortion factor for predefined signal.  Practice (P): Calculation of harmonic distortion factor for predefined signal.  2					
inusoidal signals.  Practice (P): Calculation of harmonic distortion factor for predefined signal.  Profescional companies of operation. Calculation of voltage across a capacitor for known current of the capacitor.  Non-idealities of power switches. Static and switching losses of transistors and diodes. Cooling.  Profescional companies of the static and switching losses of transistors and diodes. Cooling.  Profescional companies of the static and switching losses of a chopper. Calculation of temperature and choice of the static and switching losses of a chopper. Calculation of temperature and choice of the static and switching losses of a chopper. Calculation of parameters of seven principles of magnetic elements: defining configurations, calculation and choice of so the seven windings.  Basic design principles of magnetic elements: defining configurations, calculation and choice of so the seven windings.  One-cycle DC/DC converters: schematics, voltage and current across their coil, output voltage in continuous mode.  Parameters and choice of switches for 1-cycle DC/DC. Parameters of output capacitor and its shorted input current.  Parameters and choice of switches for 1-cycle DC/DC. Parameters of output capacitor and its shorted input current.  Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of such parameters and choice of elements (switches, capacitor and coil) of 1-cycle shorted.  Parameters and choice of elements (switches, capacitor and coil) of 1-cycle shorted.  Parameters of leedback operation of one-cycle DC/DC converters in continuous and adiscontinuous mode.  Halfifull bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  Halfifull bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  Halfiful bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  Parameters of rectifiers and operation with different load. Schematics, operation and parameters of sphase neutral-point an	L: Sinusoidal voltage and currents. Instantaneous, active, reactive and full power with sinusoidal signals.	2	3	1	4
P: Quasi-stationary mode of operation. Calculation of voltage across a capacitor for known current of the capacitor.  Non-idealities of power switches. Static and switching losses of transistors and diodes. Cooling.  P: Calculation of the static and switching losses of a chopper. Calculation of temperature and choice of the static ship.  P: Calculation of the static and switching losses of a chopper. Calculation of temperature and choice of the static ship.  P: Calculation of switches, their series and parallel connection. Minimization of parasitic parameters of the static ship principles of magnetic elements: defining configurations, calculation and choice of the static ship principles of magnetic elements: defining configurations, calculation and choice of the static ship principles of magnetic elements: defining configurations, calculation and choice of the static ship principles of magnetic elements: defining configurations, calculation and choice of the static ship principles of magnetic elements: defining configurations, calculation and choice of the static ship principles of magnetic elements: defining configurations, calculation and choice of the static ship principles of magnetic elements: defining configurations, calculation and choice of the static ship principles	L: Non-sinusoidal voltage and currents. Harmonic distortion. Power and power factor with non-sinusoidal signals.	3	2	1	4
of the capacitor.  Non-idealities of power switches. Static and switching losses of transistors and diodes. Cooling.  Non-idealities of power switches. Static and switching losses of transistors and diodes. Cooling.  Potential of the static and switching losses of a chopper. Calculation of temperature and choice of the static and switching losses of a chopper. Calculation of parasitic parameters of converters.  Basic design principles of magnetic elements: defining configurations, calculation and choice of converters.  Basic design principles of magnetic elements: defining configurations, calculation and choice of cores and windings.  One-cycle DC/DC converters: schematics, voltage and current across their coil, output voltage in continuous mode.  Parameters and choice of switches for 1-cycle DC/DC. Parameters of output capacitor and its continuous mode.  Parameters and choice of switches for 1-cycle DC/DC. Parameters of output capacitor and its continuous operation of parameters and choice of elements (switches, capacitor and coil) of 1-cycle converters.  Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of lyback converters.  Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of lyback converters.  Discontinuous mode.  Half/full bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  Integrated solutions for DC/DC converters. Operation of integrated circuits (IC) TOP250, 2 3 1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	Practice (P): Calculation of harmonic distortion factor for predefined signal.	2	3	1	4
P: Calculation of the static and switching losses of a chopper. Calculation of temperature and choice of the static and switching losses of a chopper. Calculation of temperature and choice of the static and switches, their series and parallel connection. Minimization of parasitic parameters  D: Potection of switches, their series and parallel connection. Minimization of parasitic parameters  D: Potential of converters.  Disability of the static design principles of magnetic elements: defining configurations, calculation and choice of cores and windings.  D: One-cycle DC/DC converters: schematics, voltage and current across their coil, output voltage in continuous mode.  D: Parameters and choice of switches for 1-cycle DC/DC. Parameters of output capacitor and its continuous mode.  D: Calculation of parameters and choice of elements (switches, capacitor and coil) of 1-cycle  DC/DC converters.  D: Calculation of parameters and choice of elements (switches, capacitor and coil) of 1-cycle  DC/DC converters.  Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of lyback converters.  Discontinuous mode.  Hall/full bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  Hall/full bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  Hall/full bridge DC/DC converters. Operation of integrated circuits (IC) TOP250,  Hall/full bridge DC/DC converters of 3-phase neutral-point and bridge diode rectifiers at non-symmetrical put.  Parameters of rectifiers and operation with different load. Schematics, operation and parameters of a phase neutral-point and bridge diode rectifiers at non-symmetrical put.  Poperation and parameters of 3-phase neutral-point and bridge diode rectifiers at non-symmetrical input.  Deparation of parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-yermetrical input.  Disportation of diode and thyristor rectifiers at non-zero input inductance.  Disportation of diode and thyristor recti	P: Quasi-stationary mode of operation. Calculation of voltage across a capacitor for known current of the capacitor.	3	2	1	4
of heatsink.  2. Protection of switches, their series and parallel connection. Minimization of parasitic parameters of converters.  2. Basic design principles of magnetic elements: defining configurations, calculation and choice of converters.  2. Basic design principles of magnetic elements: defining configurations, calculation and choice of converters.  2. One-cycle DC/DC converters: schematics, voltage and current across their coil, output voltage in continuous mode.  2. Parameters and choice of switches for 1-cycle DC/DC. Parameters of output capacitor and its choice. Input current.  2. Calculation of parameters and choice of elements (switches, capacitor and coil) of 1-cycle  2. 3 1 4  4. DC/DC converters.  2. Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of lyback converters.  2. Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of lyback converters.  2. Hall/full bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  3. 2 1 4  4. Hall/full bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  3. 2 1 4  4. Hall/full bridge DC/DC converters. Operation of integrated circuits (IC) TOP250,  3. 1 4  4. Hall/full bridge DC/DC converters. Operation of integrated circuits (IC) TOP250,  4. Tarameters of rectifiers and operation with different load. Schematics, operation and parameters of fectifiers and operation and parameters of a phase neutral-point and bridge diode rectifiers at non-symmetrical put.  3. 2 1 4  4. Calculation of parameters of thyristor rectifiers. Inverter mode of operation and its conditions.  3. 2 1 4  4. Calculation of parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-ymmetrical input.  4. Operation of diode and thyristor rectifiers at non-zero input inductance.  5. Calculation of parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-ymmetrical input.  5. Operation of diode and thyristor rectifiers. Power f	L: Non-idealities of power switches. Static and switching losses of transistors and diodes. Cooling.	2	3	1	4
of converters.  Discontinuous mode.  Disconverters.  Discontinuous poperation of 1-cycle DC/DC converters. Features and parameters of elements of 1/yback converters.  Discontinuous mode.  Discontinuous poperation of 1-cycle DC/DC converters. Features and parameters of elements of 1/yback converters.  Discontinuous poperation of 1-cycle DC/DC converters. Features and parameters of elements of 1/yback converters.  Discontinuous poperation of 1-cycle DC/DC converters. Features and parameters of elements of 1/yback converters.  Discontinuous poperation of 1-cycle DC/DC converters. Features and parameters of elements of 1/yback converters.  Discontinuous poperation of 1-cycle DC/DC converters in continuous and discontinuous mode.  Half/full bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  Half/full bridge DC/DC converters. Operation of integrated circuits (IC) TOP250,  VIPer28, IRS2541 un CA1524.  Parameters of rectifiers and operation with different load. Schematics, operation and parameters of 1/yback certifiers and parameters of 3-phase neutral-point and bridge diode rectifiers at non-symmetrical input.  Calculation of parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-yen and parameters of 1/y and 1/	P: Calculation of the static and switching losses of a chopper. Calculation of temperature and choice of heatsink.	3	2	1	4
cores and windings.  i. One-cycle DC/DC converters: schematics, voltage and current across their coil, output voltage in continuous mode.  i. Parameters and choice of switches for 1-cycle DC/DC. Parameters of output capacitor and its choice. Input current.  i. Calculation of parameters and choice of elements (switches, capacitor and coil) of 1-cycle DC/DC converters.  i. Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of lyback converters.  i. Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of lyback converters.  i. Discontinuous operation of one-cycle DC/DC converters in continuous and discontinuous mode.  i. Half/full bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  i. Integrated solutions for DC/DC converters. Operation of integrated circuits (IC) TOP250, VIPer28, IRS2541 un CA1524.  i. Parameters of rectifiers and operation with different load. Schematics, operation and parameters of certifiers of 3 phase neutral-point and bridge diode rectifiers at non-symmetrical input.  i. Per Calculation of parameters of 3-phase neutral-point and bridge diode rectifiers at non-symmetrical input.  i. Operation and parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-symmetrical input.  i. Operation of diode and thyristor rectifiers at non-zero input inductance.  i. Operation of diode and thyristor rectifiers at non-zero input inductance.  i. Departation of diode and thyristor rectifiers. Power factor corrector based on MC34262.  aboratory work: Operation of diode and thyristor rectifiers.	L: Protection of switches, their series and parallel connection. Minimization of parasitic parameters of converters.	2	3	1	4
continuous mode.  E Parameters and choice of switches for 1-cycle DC/DC. Parameters of output capacitor and its choice. Input current.  Calculation of parameters and choice of elements (switches, capacitor and coil) of 1-cycle  CO/DC converters.  Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of lyback converters.  Aboratory work: Open loop and feedback operation of one-cycle DC/DC converters in continuous and discontinuous mode.  Half/full bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  Autonomous inverters.  E Integrated solutions for DC/DC converters. Operation of integrated circuits (IC) TOP250, VIPer28, IRS2541 un CA1524.  Parameters of rectifiers and operation with different load. Schematics, operation and parameters of schematics of foliode rectifiers.  Poeration and parameters of 3-phase neutral-point and bridge diode rectifiers at non-symmetrical nput.  Deparation and parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-zero input inductance.  Coperation of diode and thyristor rectifiers at non-zero input inductance.  E Improvement of rectifiers utilizing pulse mode converters. Power factor corrector based on MC34262.  Laboratory work: Operation of diode and thyristor rectifiers.	L: Basic design principles of magnetic elements: defining configurations, calculation and choice of cores and windings.	3	2	1	4
Abolice. Input current.  2: Calculation of parameters and choice of elements (switches, capacitor and coil) of 1-cycle  2: Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of lyback converters.  2: Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of lyback converters.  2: Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of lyback converters.  2: Laboratory work: Open loop and feedback operation of one-cycle DC/DC converters in continuous and discontinuous mode.  2: Half/full bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  3: 2: 1: 4  4: Autonomous inverters.  2: Integrated solutions for DC/DC converters. Operation of integrated circuits (IC) TOP250, viver28, IRS2541 un CA1524.  2: Parameters of rectifiers and operation with different load. Schematics, operation and parameters of diode rectifiers and operation with different load. Schematics, operation and parameters of capacitic parameters of 3-phase neutral-point and bridge diode rectifiers at non-symmetrical nput.  3: 1: 4  4: 4  4: 4  4: 4  4: 4  5: Calculation of parameters of 3-phase neutral-point and bridge diode rectifiers at non-symmetrical input.  5: Calculation of parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-symmetrical input.  6: Coperation of diode and thyristor rectifiers at non-zero input inductance.  3: 1: 4  4: 4  4: 4  4: 4  4: 4  4: 4  5: Calculation of parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-zero input inductance.  3: 1: 4  4: 4  6: Calculation of parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-zero input inductance.  3: 1: 4  4: 4  6: Capacition of diode and thyristor rectifiers at non-zero input inductance.  3: 1: 4  4: 4  6: Capacition of diode and thyristor rectifiers at non-zero input inductance.  3: 1: 4  4: 4  6: Capacition of diode and thyristor rectifiers at non-zero input inductance.  3:	L: One-cycle DC/DC converters: schematics, voltage and current across their coil, output voltage in continuous mode.	2	3	1	4
DC/DC converters.  Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of alyback converters.  Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of alyback converters.  Description of parameters of parameters of input/output switches, transformer and coil.  Lie Half/full bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  Autonomous inverters.  Lie Integrated solutions for DC/DC converters. Operation of integrated circuits (IC) TOP250,  Lie Parameters of rectifiers and operation with different load. Schematics, operation and parameters of didode rectifiers and operation with different load. Schematics, operation and parameters of cettifiers of 3-phase neutral-point and bridge diode rectifiers at non-symmetrical nput.  Description of parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-symmetrical input.  Description of diode and thyristor rectifiers at non-zero input inductance.  Lie Improvement of rectifiers utilizing pulse mode converters. Power factor corrector based on MC34262.  Laboratory work: Operation of diode and thyristor rectifiers.  Description of diode and thyristor rectifiers at non-zero input inductance.  Description of diode and thyristor rectifiers at non-zero input inductance.  Lie Improvement of rectifiers utilizing pulse mode converters. Power factor corrector based on MC34262.  Laboratory work: Operation of diode and thyristor rectifiers.	L: Parameters and choice of switches for 1-cycle DC/DC. Parameters of output capacitor and its choice. Input current.	3	2	1	4
Autonomous inverters.  Laboratory work: Open loop and feedback operation of one-cycle DC/DC converters in continuous and discontinuous mode.  Li Half/full bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  Autonomous inverters.  Li Integrated solutions for DC/DC converters. Operation of integrated circuits (IC) TOP250, 2 3 1 4 4 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	P: Calculation of parameters and choice of elements (switches, capacitor and coil) of 1-cycle DC/DC converters.	2	3	1	4
and discontinuous mode.  L: Half/full bridge DC/DC converters. Parameters of input/output switches, transformer and coil.  Autonomous inverters.  L: Integrated solutions for DC/DC converters. Operation of integrated circuits (IC) TOP250, VIPer28, IRS2541 un CA1524.  L: Parameters of rectifiers and operation with different load. Schematics, operation and parameters of diode rectifiers.  P: Calculation of parameters of 3-phase neutral-point and bridge diode rectifiers at non-symmetrical nput.  Departion 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.  Departion of diode and thyristor rectifiers at non-zero input inductance.  3 2 1 4  Departion of diode and thyristor rectifiers at non-zero input inductance.  3 2 1 4  Departion of diode and thyristor rectifiers at non-zero input inductance.  3 2 1 4  Departion of diode and thyristor rectifiers at non-zero input inductance.  3 2 1 4  Departion of diode and thyristor rectifiers at non-zero input inductance.  3 2 1 4  Departion of diode and thyristor rectifiers at non-zero input inductance.  3 2 1 4  Departion of diode and thyristor rectifiers at non-zero input inductance.  3 2 1 4  Departion of diode and thyristor rectifiers at non-zero input inductance.  3 2 1 4  Departion of diode and thyristor rectifiers at non-zero input inductance.  3 2 1 4  Departion of diode and thyristor rectifiers at non-zero input inductance.  3 2 1 4  Departion of diode and thyristor rectifiers at non-zero input inductance.  3 2 1 4  Departion of diode and thyristor rectifiers at non-zero input inductance.  3 2 1 4  Departion of diode and thyristor rectifiers at non-zero input inductance.  3 2 1 4  Departicular dep	L: Discontinuous operation of 1-cycle DC/DC converters. Features and parameters of elements of flyback converters.	3	2	1	4
Autonomous inverters.  L: Integrated solutions for DC/DC converters. Operation of integrated circuits (IC) TOP250,  VIPer28, IRS2541 un CA1524.  L: Parameters of rectifiers and operation with different load. Schematics, operation and parameters  of diode rectifiers.  C: Calculation of parameters of 3-phase neutral-point and bridge diode rectifiers at non-symmetrical nput.  Deparation and parameters of thyristor rectifiers. Inverter mode of operation and its conditions.  C: Calculation of parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-symmetrical input.  D: Calculation of parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-symmetrical input.  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.  Laboratory work: Operation of diode and thyristor rectifiers.  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
VIPer28, IRS2541 un CA1524.  L: Parameters of rectifiers and operation with different load. Schematics, operation and parameters of diode rectifiers.  P: Calculation of parameters of 3-phase neutral-point and bridge diode rectifiers at non-symmetrical nput.  Deparation and parameters of thyristor rectifiers. Inverter mode of operation and its conditions.  P: Calculation of parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-symmetrical input.  L: Operation of diode and thyristor rectifiers at non-zero input inductance.  L: Improvement of rectifiers utilizing pulse mode converters. Power factor corrector based on MC34262.  L: Laboratory work: Operation of diode and thyristor rectifiers.  3 2 1 4  4 2 4  4 4 4 5 6 6 7 6 7 6 7 6 7 6 7 6 7 6 7 6 7 6 7	L: Half/full bridge DC/DC converters. Parameters of input/output switches, transformer and coil. Autonomous inverters.	3	2	1	4
of diode rectifiers.  2: Calculation of parameters of 3-phase neutral-point and bridge diode rectifiers at non-symmetrical popuration and parameters of thyristor rectifiers. Inverter mode of operation and its conditions.  3: 2: 1: 4  2: Calculation of parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-symmetrical input.  3: Description of diode and thyristor rectifiers at non-zero input inductance.  3: 2: 1: 4  4: Description of diode and thyristor rectifiers at non-zero input inductance.  3: 2: 1: 4  4: Description of diode and thyristor rectifiers at non-zero input inductance.  3: 3: 1: 4  4: Description of diode and thyristor rectifiers at non-zero input inductance.  3: 3: 1: 4  4: Description of diode and thyristor rectifiers.  3: 3: 1: 4  4: Description of diode and thyristor rectifiers.  3: 3: 3: 4  4: Description of diode and thyristor rectifiers.	L: Integrated solutions for DC/DC converters. Operation of integrated circuits (IC) TOP250, VIPer28, IRS2541 un CA1524.	2	3	1	4
Departion and parameters of thyristor rectifiers. Inverter mode of operation and its conditions.  2: Calculation of parameters of 3-phase neutral-point and bridge thyristor rectifiers at non-symmetrical input.  2: Operation of diode and thyristor rectifiers at non-zero input inductance.  3: 2: 1: 4  2: Improvement of rectifiers utilizing pulse mode converters. Power factor corrector based on MC34262.  3: 4: 4  4: Advantage of thyristor rectifiers. Available of the provided in the provided	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 thyristor rectifiers at non- symmetrical input.  D: Operation of diode and thyristor rectifiers at non-zero input inductance.  D: Improvement of rectifiers utilizing pulse mode converters. Power factor corrector based on MC34262.  Caboratory work: Operation of diode and thyristor rectifiers.  D: A diagram of the diode and thyristor rectifiers.  D: A diagram of the diode and thyristor rectifiers.  D: A diagram of the diode and thyristor rectifiers.  D: A diagram of the diode and thyristor rectifiers.  D: A diagram of the diode and thyristor rectifiers.  D: A diagram of the diode and thyristor rectifiers.  D: A diagram of the diode and thyristor rectifiers.  D: A diagram of the diode and thyristor rectifiers.  D: A diagram of the diode and thyristor rectifiers.  D: A diagram of the diode and thyristor rectifiers.  D: A diagram of the diode and thyristor rectifiers.  D: A diagram of the diode and thyristor rectifiers.	P: Calculation of parameters of 3-phase neutral-point and bridge diode rectifiers at non-symmetrical input.	2	3	1	4
symmetrical input.  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.  Laboratory work: Operation of diode and thyristor rectifiers.  3 2 1 4	Operation and parameters of thyristor rectifiers. Inverter mode of operation and its conditions.	3	2	1	4
L: Improvement of rectifiers utilizing pulse mode converters. Power factor corrector based on MC34262.  Laboratory work: Operation of diode and thyristor rectifiers. 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
MC34262.  Laboratory work: Operation of diode and thyristor rectifiers.  3 2 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
Total: 60 60 24 96	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	СР		Hours	Tests			
		Lectures	Practical	Lab.	Test	Exam	Work
1.	4.5	3.0	0.0	0.0		*	