Zał. nr 1 do uchwały nr 43/2015 Rady Wydziału Elektrycznego PB z dnia 20.05.2015 r.

BIAŁYSTOK UNIVERSITY OF TECHNOLOGY

FACULTY OF ELECTRICAL ENGINEERING

PROGRAMME OF DOCTORAL STUDIES

Study programme
ELECTROTECHNICS

Dean of the faculty

Białystok 2015

Contents

1. General profile of the programme

1. Area of the study plan: electrotechnics.

2. Level of the study (according to Polish taxonomy): III level (doctoral study).
   Level of the study (according to international taxonomy): PhD study.

3. Educational profile: academic.
   Area of education: technical sciences.

4. Related disciplines of science, partially considered within the programme and the learning outcomes: electronics, automatic control and robotics, information technology, power engineering.

5. Formal degree conferred once a student completes the programme and successfully defends his/her PhD thesis: doctoral degree (PhD) in electrical engineering.

6. Formal frames of the doctoral programme in Bialystok University of Technology (BUT)
   The presented doctoral programme is fully coherent with European regulations concerning the third level study. Common formal requirements of the doctoral programme, including admission and organisation of the studies, comply with national regulations, including:
   - The act of Polish Parliament: Ustawa z dnia 27 lipca 2005 r., Prawo o szkolnictwie wyższym (Dz. U. Nr 164, poz. 1365 z późn. zm.);
   - The act of Polish Parliament: Ustawa z dnia 14 marca 2003 r. o stopniach naukowych i tytule naukowym oraz stopniach i tytule w zakresie sztuki (Dz. U. 2003 nr 65 poz. 595 z późn. zm.).

   Some formal, internal regulations are determined at the level of Białystok University of Technology. They are expressed in several resolutions of the Senate of BUT, including:
   - Statute of the Doctoral Programmes in Bialystok University of Technology;
   - annual resolutions of the Senate of Bialystok University of Technology concerning conditions and procedures of enrolment on doctoral programmes;
   - annual resolution of the Board of the Faculty of Electrical Engineering regarding the maximum number of PhD students and schedule of enrolment.

7. Aims of the doctoral programme.

   The doctoral programme is proposed as a direct continuation of postgraduate studies in electrical engineering, including electrotechnics, electronics, power engineering and some adjacent areas.

   The principal aim of the programme is to create an environment in which PhD students can develop their knowledge and scientific abilities and work out new technologies connected with electrical engineering.

   The proposed doctoral programme enables students to prepare the doctoral thesis and to pass the required exams. The students complete the required educational modules in 8 semesters. During this period they can develop their own scientific programme related to electrical engineering. Each student has to gather 45 ECTS (European Credit Transfer and Accumulation System) within the 8 semesters of study (including compulsory and optional educational modules). The organisation of lectures makes it possible to finalise and defend the PhD thesis in 8 semesters.

   Students who have completed the doctoral programme will be able to:
   - describe and explain theories and empirical results in the field of electrical engineering;

- formulate research questions within the area of electrotechnics, particularly related to the subject of the developed scientific problem;
- use scientific methods, critically analyse and evaluate applied methods and algorithms;
- develop new theories and technologies related to the subject of the scientific work;
- present the results of the research and discuss them in the scientific community;
- assess ethical aspects of research;
- identify needs for new research and development of new, advanced technologies;
- participate in scientific collaborations;
- analyse the role of research in societal development.

All students who have passed the required doctoral exams and successfully defended their thesis obtain the PhD degree (doctoral degree) in electrotechnics.

8. Target groups of the programme

The doctoral programme in electrotechnics is intended for postgraduate students from disciplines connected with electrical engineering, including electrotechnics, electronics, power engineering, and other related sub-areas.

A person holding a master's degree (or equivalent) in other disciplines can be qualified to the programme.

9. Basic eligibilities to the doctoral programme

Every candidate to the PhD programme has to choose a supervisor of their planned scientific programme. The supervisor should be selected from the official list of professors and qualified doctors. The list is available in the secretariat of the doctoral programme and on the web page of the programme. The head of the doctoral programme can help candidates to find the right supervisor. In this case, candidates should contact directly the office of the programme, and send preliminary information about the subject of the planned scientific work.

10. Procedure of enrolment

The qualification process to the doctoral programme consists of three steps: registration of applications, interviews with the candidates, and final (internal) selection of the candidates.

A. Registration of applications

A candidate has to prepare and send complete, required documentation, including:

- filled-in application form (available from the web page of the doctoral programme);
- signed Curriculum Vitae, including (optionally) any additional documents (e.g. a list of publications, information on formal and informal qualifications, professional experience, letters of recommendation) that can prove his/her research potential;
- declaration of the supervisor (the form is available from the web page of the doctoral programme);
- proposition of the subject of research work and a provisional plan of research. The plan must be approved and signed by the supervisor;
- authenticated copies of relevant certificates from the previous (postgraduate) studies where the master's degree or the related degree was granted;
- medical certificate;
- receipt of application fee payment;
- 4 photos.

All documents should be prepared in English. Any documents in other languages have to be accompanied by an authenticated English translation.

The electronic versions of documents can be sent by e-mail to the office of the doctoral programme (e-

mail address: we.doktoranckie@we.pl). The printed and signed versions of documents have to be sent to the following address until the end of May:

Bialystok University of Technology
Faculty of Electrical Engineering, Doctoral Programme
ul . Wiejska 45A
15-351 Bialystok
Poland

B. Interview of the candidates

The acceptance of a candidate is based on the examination of his/her documents followed by an interview in the form of a face-to-face talk in the presence of the Admission Committee for the PhD programme and of the head of the Faculty. In special cases there is a possibility to make the interview in the form of a teleconference.

C. Final (internal) selection of the candidates

Selection of the applications is carried out by July 15. The candidates qualified to the programme receive detailed information about the fee payment and are obliged to pay it by September 20.

10. Fees and funding

Bialystok University of Technology does not offer any scholarships for foreign PhD students, however, some funding is available through the Polish Government Scholarship scheme which covers tuition fees and provides additional money for living.

PhD students can contact the Polish embassy or consulate in their home country to inquire about the relevant eligibility conditions in their case. They may also seek support through the new Erasmus+ programme or, in the case of non-European students, through ongoing partnerships and opportunities set up under the Erasmus Mundus banner.

2. Subject study plan

2.1. Learning outcomes for the doctoral programme

Symbols of learning outcomes (table 1) are constructed using the scheme:

- EL3_ – acronym of the study programme (i.e. electrotechnics, third level – doctoral programme);
- W, U or K – category of learning outcomes:
  - W – category of knowledge;
  - U – category of skills;
  - K – category of social competence.
- 01, 02, 03 and subsequent numbers – number of a learning outcome.

Table 1. The learning outcomes for doctoral programme (III level study),
according to the resolution of the Senate of Białystok University of Technology (no 303/XXI/XIV/2014)

Symbol of learning outcome	Learning outcomes (LO) related to knowledge After completing a third-cycle course in the field of *electrotechnics*, graduates:
EL3_W01	have an advanced knowledge of basic issues concerning the scientific area and discipline (disciplines) related to the area of their research;
EL3_W02	have a well-grounded, theoretically-based knowledge of details connected to the area of their research (coming mainly from scientific publications), including the latest scientific achievements in the area of this research;
EL3_W03	know of the methodology of conducting scientific research, and the legal and ethical aspects of scientific work (including the methods of preparing a work to publication and presenting research results);
EL3_W04	have a basic knowledge of obtaining and conducting research projects, including the economic and legal aspects of project implementation;
EL3_W05	have a basic knowledge of technology transfer as well as commercialisation of research results, especially of issues regarding intellectual property protection;
EL3_W06	know of the methodology and techniques of teaching with the use of new technologies;
	Learning outcomes (LO) related to skills After completing a third-cycle course in the field of *electrotechnics*, graduates:
EL3_U01	can effectively acquire information (connected with their scientific work) from different sources, also in foreign languages; graduates can select and interpret this information in an appropriate way;
EL3_U02	can critically evaluate results of both their own and other people's research and other creative work as well as their contribution to the development of the discipline they represent, using the acquired knowledge; in particular, graduates can assess the usefulness and possibility of applying results of theoretical work in practice;
EL3_U03	can identify and formulate complex tasks and problems related to the scientific discipline they represent, including conceptually new tasks and research problems which may lead to innovative technical solutions;
EL3_U04	can solve complex tasks and problems connected with the scientific discipline they represent (including non-standard tasks), using conceptually new methods, thus contributing to the development of knowledge, or innovative solutions of practical value whose level of originality justifies their publication in reviewed scientific journals;
EL3_U05	can plan and implement, in a methodologically correct way, their own research projects related to scientific work conducted in bigger teams;

Table 1 (continued)

EL3_U06	can prepare documentation of research work results as well as scientific publications, also in a foreign language, according to the principles of developing such publications, with particular attention paid to the copyright law;
EL3_U07	can communicate efficiently in an international scientific and professional environment, using different technologies, also in a foreign language; graduates have the ability to present their achievements and ideas in an understandable way, and to use appropriate arguments in scientific discussions;
EL3_U08	are prepared to teach students in a methodologically correct way, using modern educational technologies;
	Learning outcomes (LO) related to competence After completing a third-cycle course in the field of *electrotechnics*, graduates:
EL3_K01	realise and feel the need for further education, for improving their professional and personal competence, and for analysing the latest achievements related to the scientific discipline they represent;
EL3_K02	realise the importance of behaving in a professional way, adhering to the principles of professional ethics, and developing the ethos of their scientific and professional environment;
EL3_K03	can think and work in an independent and creative way; graduates begin to generate new ideas, seek innovative solutions, and determine new areas of research;
EL3_K04	realise and feel the need for getting involved in the process of educating specialists in their engineering discipline as well as in other activities for the development of a knowledge-based society;
EL3_K05	are aware of the social role of graduates of third-cycle courses, and understand the need to communicate to the society information and opinions concerning scientific and technological achievements.

2.2. Organisation and plan of the programme

1. Form of the programme: full time.
2. Number of semesters: 8 (4 years).
3. Number of ECTS points necessary to complete the programme: 45.
4. Length of a semester: 15 weeks of classes.
5. Form of assessment of modules:
   - examination at the end of selected modules (denoted by E in tables 3 and 4);
   - assessment with final mark at the end of other modules.

   A PhD student obtains ECTS points after a positive assessment of the module, i.e. after passing the exam or obtaining a positive mark from the other modules. According to the general conditions students have to pass all exams and have to receive credits for all other classes.
   The PhD programme is completed when all requirements given in the Table 1 are satisfied.

6. At the conclusion of the programme, the supervisor confirms that the prepared thesis is of a suitable standard to be presented for examination. It is required to defend it before one or more academic experts, including those from outside of Bialystok University of Technology. The defence is public. Following a satisfactory defence of the thesis and the completion of all required coursework, teaching duties and other training, the student is awarded a PhD qualification that represents a particularly comprehensive level of academic achievement.

7. General plan of the programme

The plan of the doctoral programme includes:

- a set of obligatory educational modules (generally lectures);
- a set of optional modules;
- individual assessment of the current status of scientific work. Student has to pursue their scientific plan of work with the supervisor.

The participants of the doctoral programme can take part in:

- any other lectures on the Faculty of Electrical Engineering and Bialystok University of Technology;
- scientific conferences and seminars organised or co-organised by the Faculty of Electrical Engineering or Bialystok University of Technology;
- internal seminars organised by departments of the Faculty of Electrical Engineering;
- other works specified in the individual plane.

Abbreviations used in the plan of study and in the syllabuses:

- form of the module
  - L – lecture,
  - E – exercises,
  - LC – laboratory class,
  - P – project,
  - SW – specialized workshop,
  - S – seminar;
- method of assessment:
  - E – exam,
  - M – assessment with final mark.

Table 2. General plan of the doctoral programme in *electrotechnics*

Semester 1		Semester 2		Semester 3		Semester 4		Semester 5		Semester 6		Semester 7		Semester 8	
Mathematics	30 L 2 ECTS	Automatic control theory	30 L 2 ECTS	Powering systems of electric and electronic devices	30 L 2 ECTS							English	15 E 1 ECTS		
Advanced topics of theoretical electrotechnics	30 L 2 ECTS	Optoelectronic systems	30 L 2 ECTS	Theory and application of discrete systems	15 L 1 ECTS										
Methodology of research	15 L 1 ECTS			Approximate solution methods of techn. electr. problems	15 L 1 ECTS										
Didactics of higher school	30 L 15 E 3 ECTS														
		Optional modules (1)	30 L/E/S 2 ECTS	Optional modules (1)	60 L/E 4 ECTS	Optional modules (1)	60 L/E 4 ECTS	Optional modules (1)	60 L/E 4 ECTS	Optional modules (1)	60 L/E 4 ECTS	Optional modules (1)	30 L 2 ECTS		
		PhD seminar	15 S 1 ECTS			PhD seminar	15 S 1 ECTS			PhD seminar	15 S 1 ECTS			PhD seminar	15 S 1 ECTS
		Practices – conducting or participating in university courses	15 1 ECTS			Practices – conducting or participating in university courses	15 1 ECTS			Practices – conducting or participating in university courses	15 1 ECTS			Practices – conducting or participating in university courses	15 1 ECTS
Individual PhD research program	0 ECTS	Individual PhD research program	0 ECTS	Individual PhD research program	0 ECTS	Individual PhD research program	0 ECTS	Individual PhD research program	0 ECTS	Individual PhD research program	0 ECTS	Individual PhD research program	0 ECTS	Individual PhD research program	0 ECTS
Sum of hours	120		120		120		90		60		90		45		30
Sum of ECTS	8		8		8		6		4		6		3		2

(1) Optional modules are specified in table 4.

Table 3. List of compulsory modules within the doctoral programme in electrotechnics

Semester	Module name	Module ID	Form of the module and total number of hours				Method of assessment	ECTS
			Lectures (L)	Exercises (E)	Laboratory (LC)	Seminar (S)		
1	Mathematics	ES3D O11 01	30				E	2
	Advanced topics of theoretical electrotechnics	ES3D O11 02	30				E	2
	Methodology of research	ES3D O11 03	15				M	1
	Didactics of higher school	ES3D O11 04	30	15			M	3
	Individual PhD research program	ES3D O11 12	-	-	-	-	M	0
2	Automatic control theory	ES3D O22 01	30				E	2
	Optoelectronic systems	ES3D O22 02	30				E	2
	PhD seminar	ES3D O22 10				15	M	1
	Practices – conducting or participating in university courses	ES3D O22 11		15			M	1
	Individual PhD research program	ES3D O22 12	-	-	-	-	M	0
3	Powering systems of electric and electronic devices	ES3D O33 01	30				E	2
	Theory and application of discrete systems	ES3D O33 02	15				E	1
	Approximate solution methods of technical electrodynamics problems	ES3D O33 03	15				M	1
	Individual PhD research program	ES3D O33 12	-	-	-	-	M	0
4	PhD seminar	ES3D O44 10				15	M	1
	Practices – conducting or participating in university courses	ES3D O44 11		15			M	1
	Individual PhD research program	ES3D O44 12	-	-	-	-	M	0
5	Individual PhD research program	ES3D O55 12	-	-	-	-	M	0
6	PhD seminar	ES3D O66 10				15	M	1
	Practices – conducting or participating in university courses	ES3D O66 11		15			M	1
	Individual PhD research program	ES3D O66 12	-	-	-	-	M	0

Table 3 (continued)

7	English	ES3D O77 01		15			E	1
	Individual PhD research program	ES3D O77 12	-	-	-	-	M	0
8	PhD seminar	ES3D O88 10				15	M	1
	Practices – conducting or participating in university courses	ES3D O88 11		15			M	1
	Individual PhD research program	ES3D O88 12	-	-	-	-	M	0

Table 4. List of optional modules within the doctoral programme in electrotechnics

Semester	Module name	Module ID	Form of the module and total number of hours				Method of assessment	ECTS
			Lectures (L)	Exercises (E)	Laboratory (LC)	Seminar (S)		
2	Modern trends in university teaching	ES3D W22 01	15	15			M	2
	Modern information methods and techniques in teaching	ES3D W22 02	15				M	1
	Basics of self-presentation	ES3D W22 03				15	M	1
3	Selected problems of dynamical system theory	ES3D W33 01	30				M	2
	Modern electronic materials	ES3D W33 02	30				M	2
	Thermography	ES3D W33 03	15				M	1
	Power electronics in integrated photovoltaic power systems	ES3D W33 04	15				M	1
	Applied informatics	ES3D W33 05	30				M	2
	Mathematical modelling of dynamic systems	ES3D W33 06	30				M	2
	Electromagnetic compatibility	ES3D W33 07	30				M	2
	Optimisation methods	ES3D W33 08	30				M	2
	Mathematical statistics	ES3D W33 09	15				M	1
	English	ES3D W33 10		15			M	1

Table 4 (continued)

4	Approximated methods in integral and differential calculus	ES3D W44 01	30				M	2
	Electronic equipment devices	ES3D W44 02	30				M	2
	Methods and algorithms of artificial intelligence	ES3D W44 03	30				M	2
	Dynamical systems with uncertain parameters	ES3D W44 04	30				M	2
	Theory of fractional systems	ES3D W44 05	30				M	2
	Modern metrology	ES3D W44 06	15				M	1
	Analysis and synthesis of non-linear systems	ES3D W44 07	30				M	2
	Selected aspects of electric shock protection	ES3D W44 08	15				M	1
	Fractional electrical circuits	ES3D W44 09	15				M	2
	English	ES3D W44 10		15			M	1
5	Unconventional energy sources	ES3D W55 01	30				M	2
	Advanced methods of analysis and synthesis of drive systems	ES3D W55 02	30				M	2
	Application software for the analysis and design of drive systems and inverters	ES3D W55 03	30				M	2
	Electric power networks	ES3D W55 04	30				M	2
	Intelligent lighting	ES3D W55 05	15				M	1
	Transmission of electromagnetic waves	ES3D W55 06	30				M	2
	Control and operation of power systems	ES3D W55 07	15				M	1
	English	ES3D W55 10		15			M	1
6	Safety and operation of energy systems	ES3D W66 01	15				M	1
	Power systems	ES3D W66 02	30				M	2
	Modelling and study of the phenomena of line-to-earth short-circuit	ES3D W66 03	15				M	1
	Optical fibers technology	ES3D W66 04	30				M	2
	Nanotechnology	ES3D W66 05	30				M	2
	Power electronics in smart grids	ES3D W66 06	30				M	2
	Effects of electromagnetic fields on living organisms	ES3D W66 07	15				M	1
	English	ES3D W66 10		15			M	1

Table 4 (continued)

7	Interpersonal communication	ES3D W77 01	15				M	1
	Determinants of enterprise competitiveness	ES3D W77 02	15				M	1
	Modern theories of enterprise and production factors	ES3D W77 03	15				M	1
	Economy	ES3D W77 04	15				M	1

8. Matrix of learning outcomes.

Table 5. Matrix of learning outcomes for compulsory modules within the doctoral programme in electrotechnics

Semester	Module name	Module ID	Learning outcomes related to knowledge						Learning outcomes related to skills								Learning outcomes related to competence				
			EL3_W01	EL3_W02	EL3_W03	EL3_W04	EL3_W05	EL3_W06	EL3_U01	EL3_U02	EL3_U03	EL3_U04	EL3_U05	EL3_U06	EL3_U07	EL3_U08	EL3_K01	EL3_K02	EL3_K03	EL3_K04	EL3_K05
1	Mathematics	ES3D O11 01	●						●		●								●		
	Advanced topics of theoretical electrotechnics	ES3D O11 02			●	●						●	●	●					●		
	Methodology of research	ES3D O11 03			●					●			●	●				●			●
	Didactics of higher school	ES3D O11 04						●							●	●	●	●		●	●
	Individual PhD research program	ES3D O11 12		●	●	●	●		●	●	●	●	●	●	●		●	●	●		●
2	Automatic control theory	ES3D O22 01	●	●						●	●						●				
	Optoelectronic systems	ES3D O22 02	●	●					●								●		●		
	PhD seminar	ES3D O22 10			●				●	●				●	●		●				
	Practices – conducting or participating in university courses	ES3D O22 11						●								●	●	●		●	●
	Individual PhD research program	ES3D O22 12		●	●	●	●		●	●	●	●	●	●	●		●	●	●		●
	Optional modules	ES3D W22 **			○			○							○	○	○			○	○
3	Powering systems of electric and electronic devices	ES3D O33 01	●	●					●								●				
	Theory and application of discrete systems	ES3D O33 02	●						●	●							●				
	Approximate solution methods of technical electrodynamics problems	ES3D O33 03	●	●					●			●					●				
	Individual PhD research program	ES3D O33 12		●	●	●	●		●	●	●	●	●	●	●		●	●	●		●
	Optional modules	ES3D W33 **	○	○	○		○		○	○	○	○	○	○	○		○	○	○		○
4	PhD seminar	ES3D O44 10			●				●	●				●	●		●				
	Practices – conducting or participating in university courses	ES3D O44 11						●								●	●	●		●	●
	Individual PhD research program	ES3D O44 12		●	●	●	●		●	●	●	●	●	●	●		●	●	●		●
	Optional modules	ES3D W44 **	○	●	○		○		○	○	○	○		○	○		○	○	○		○
5	Individual PhD research program	ES3D O55 12		●	●	●	●		●	●	●	●	●	●	●		●	●	●		●
	Optional modules	ES3D W55 **	○	●			○		○	○	○	○	○	○	○		○	○	○	○	○
6	PhD seminar	ES3D O66 10			●				●	●				●	●		●				
	Practices – conducting or participating in university courses	ES3D O66 11						●								●	●	●		●	●
	Individual PhD research program	ES3D O66 12		●	●	●	●		●	●	●	●	●	●	●		●	●	●		●
	Optional modules	ES3D W66 **	○	○			○		○	○	○			○	○		○	○	○	○	○
7	English	ES3D O77 01							●					●	●		●				
	Individual PhD research program	ES3D O77 12		●	●	●	●		●	●	●	●	●	●	●		●	●	●		●
	Optional modules	ES3D W77 **				○	○	○					○		○	○	●	●	○		○
8	PhD seminar	ES3D O88 10			●				●	●				●	●		●				
	Practices – conducting or participating in university courses	ES3D O88 11						●								●	●	●		●	●
	Individual PhD research program	ES3D O88 12		●	●	●	●		●	●	●	●	●	●	●		●	●	●		●
Number of modules which fulfil the selected learning outcome			6	14	14	9	8	5	18	15	10	10	10	15	14	5	24	15	11	5	14

Table 6. Matrix of learning outcomes for optional modules within the doctoral programme in electrotechnics

Semester	Module name	Module ID	Learning outcomes related to knowledge						Learning outcomes related to skills								Learning outcomes related to competence				
			EL3_W01	EL3_W02	EL3_W03	EL3_W04	EL3_W05	EL3_W06	EL3_U01	EL3_U02	EL3_U03	EL3_U04	EL3_U05	EL3_U06	EL3_U07	EL3_U08	EL3_K01	EL3_K02	EL3_K03	EL3_K04	EL3_K05
2	Modern trends in university teaching	ES3D W22 01						●								●				●	●
	Modern information methods and techniques in teaching	ES3D W22 02						●								●	●				
	Basics of self-presentation	ES3D W22 03			●										●						●
3	Selected problems of dynamical system theory	ES3D W33 01	●	●						●							●				
	Modern electronic materials	ES3D W33 02		●					●	●							●				●
	Thermography	ES3D W33 03	●	●					●	●											
	Power electronics in integrated photovoltaic	ES3D W33 04	●	●					●	●							●				
	Applied informatics	ES3D W33 05	●	●	●					●		●					●				
	Mathematical modelling of dynamic systems	ES3D W33 06		●					●	●	●								●		
	Electromagnetic compatibility	ES3D W33 07		●	●				●	●							●	●			●
	Optimisation methods	ES3D W33 08	●	●						●							●				
	Mathematical statistics	ES3D W33 09	●		●					●	●		●								
	English	ES3D W33 10		●			●		●					●	●		●	●			●
4	Approximated methods in integral and differential calculus	ES3D W44 01	●	●						●	●	●					●				
	Electronic equipment devices	ES3D W44 02	●	●	●				●								●				
	Methods and algorithms of artificial intelligence	ES3D W44 03		●						●	●								●		
	Dynamical systems with uncertain parameters	ES3D W44 04	●	●						●							●				
	Theory of fractional systems	ES3D W44 05	●	●						●							●				
	Modern metrology	ES3D W44 06	●	●					●								●				
	Analysis and synthesis of non-linear systems	ES3D W44 07	●	●	●					●							●				
	Selected aspects of electric shock protection	ES3D W44 08	●	●					●		●						●	●			
	Fractional electrical circuits	ES3D W44 09	●	●						●							●				
	English	ES3D W44 10		●			●		●					●	●		●	●			●
5	Unconventional energy sources	ES3D W55 01	●	●					●	●	●						●	●			●
	Advanced methods of analysis and synthesis of drive systems	ES3D W55 02		●					●	●	●	●					●				
	Application software for the analysis and design of drive systems and inverters	ES3D W55 03		●							●	●	●				●				
	Electric power networks	ES3D W55 04	●	●							●	●									
	Intelligent lighting	ES3D W55 05	●	●					●	●	●						●		●		
	Transmission of electromagnetic waves	ES3D W55 06	●	●					●		●						●				
	Control and operation of power systems	ES3D W55 07	●	●						●	●			●			●			●	
	English	ES3D W55 10		●			●		●					●	●		●	●			●

Table 6 (continued)

Semester	Module name	Module ID	Learning outcomes related to knowledge						Learning outcomes related to skills								Learning outcomes related to competence				
			EL3_W01	EL3_W02	EL3_W03	EL3_W04	EL3_W05	EL3_W06	EL3_U01	EL3_U02	EL3_U03	EL3_U04	EL3_U05	EL3_U06	EL3_U07	EL3_U08	EL3_K01	EL3_K02	EL3_K03	EL3_K04	EL3_K05
6	Safety and operation of energy systems	ES3D W66 01	●						●	●							●				
	Power systems	ES3D W66 02		●						●	●									●	
	Modelling and study of the phenomena of line-to-earth short-circuit	ES3D W66 03		●					●	●				●					●		
	Optical fibers technology	ES3D W66 04	●	●					●	●	●						●				
	Nanotechnology	ES3D W66 05	●	●					●	●	●						●				
	Power electronics in smart grids	ES3D W66 06	●	●					●								●				
	Effects of electromagnetic fields on living organisms	ES3D W66 07		●					●		●						●	●			●
	English	ES3D W66 10		●			●		●					●	●		●	●			●
7	Interpersonal communication	ES3D W77 01						●					●		●	●	●	●			●
	Determinants of enterprise competitiveness	ES3D W77 02				●	●						●				●	●			
	Modern theories of enterprise and production factors	ES3D W77 03				●	●										●	●			
	Economy	ES3D W77 04				●											●	●	●		●

3. Syllabuses of compulsory modules

The overall (general) programme, basic references and some requirements of compulsory modules are described on the following pages.

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Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Mathematics**				
Module type:	**compulsory**	Semester: **1**	ECTS: **1**	Module ID:	**ES3D O11 01**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to familiarise students with some of the problems of advanced mathematical analysis and differential equations, to train skills enabling application of this knowledge.				
Assessment:	written exam.				
Module content:	Linear space. Systems of equations with rectangular matrix of coefficients. Vector analysis. Stability of solutions to systems of differential equations. Lyapunov's methods. Partial differential equations of the I^{ts} order (linear and quasi-linear). Partial differential equations of the IInd order (classification, examples of parabolic, hyperbolic, elliptic equations and methods of solving them). Calculus of variations, Euler's equation, isoparametric problem, transversality. Some problems of differential geometry: flow of vector field, Lie bracket, involute and integral distributions, Frobenius Theorem.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has advanced knowledge about some problems regarding linear spaces, vector analysis, stability of ordinary differential equations, partial differential equations (EL3_W01);				
LO2	has advanced knowledge about some problems regarding calculus of variations and differential geometry. (EL3_W01);				
LO3	can see and formulate complex problems that can be described by mathematical models (EL3_U01, EL3_U03);				
LO4	can independently and creatively solve problems (EL3_K03).				
Basic references:	1. MacCluer B. D.: Elementary functional analysis. Springer-Verlag, Berlin, 2009 2. Mozyrska D., Pawłuszewicz E., Stasiewicz R.: Równania różniczkowe zwyczajne: metody klasyczne i metoda operatorowa. Wydawnictwa Politechniki Białostockiej, Białystok, 2001. 3. Palczewski A.: Równania różniczkowe zwyczajne: teoria i metody numeryczne z wykorzystaniem komputerowego systemu obliczeń symbolicznych. WNT, Warszawa, 2004. 4. Balakrishnan A. V.: Analiza funkcjonalna stosowana. PWN, Warszawa, 1992. 5. Kordecki W.: Rachunek prawdopodobieństwa i statystyka matematyczna. GiS, Warszawa, 2002. 6. Gancarzewicz J.: Geometria różniczkowa. PWN, Warszawa, 1987. 7. Łobos E., Sikora B.: Advanced Calculus - Selected Topics. Silesian University, 2009.				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written exam;	L
LO2	written exam;	L
LO3	written exam;	L
LO4	written exam.	L

Department:	Faculty of Mechanical Engineering	Tutors:	E. Pawłuszewicz
Date:	30.01.2015	Coordinator:	**Ewa Pawłuszewicz, D.Sc., Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Advanced topics of theoretical electrotechnics**				
Module type:	**compulsory**	Semester: **1**	ECTS: **2**	Module ID:	**ES3D O11 02**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to provide an extended mathematical formulation of some complex cases in electrical engineering related to linear and large scale lumped electrical circuits; to familiarise students with chosen methods implemented in the analysis of non-linear circuits; to review the basic concepts of operator calculus and specific time-frequency representation of analog signals; to recognise phenomena and methods of analysis of transient states in single-dimensional distributed circuits.				
Assessment:	final written test and oral presentation of some cases.				
Module content:	Functional spaces of periodic, power limited signals and a class of energy limited impulses. Mathematical background of operator calculus and physical interpretation of specific transformations. Properties and implementation of chosen time-frequency and time-time transformations (Hankel transform, wavelets). Generalised concept of electric power. Frequency domain and time domain theories of power. Extended discussion on some modern concepts of power (optimisation theory, ps-qs scheme, wavelet theory of power). Compatibility of the discussed power theories. Block diagrams of circuits and graphs (signal, floating schemes) in circuit theory. Mason's graphs: construction, extended interpretation, methods of reduction. Kron's diacoptics: basic methods of circuit decomposition, multi-domain analysis of large scale circuits. Analysis of large scale and periodic circuits. Local and global metrics. Nonlinear electrical circuits: remarks on analytical methods (the phase-space method, the local average method). Formulation and implementation of the homotopia theory: linear scheme, fix-point method and Newton's scheme. Transient states in transmission lines: methods of analysis, interpretation of the phenomena.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has advanced knowledge on the mathematical formalism applied in the theory of analog electrical circuits and in the theory of analog, power limited and energy limited signals (EL3_W01);				
LO2	has detailed, theoretical knowledge concerning some analytical methods of electrotechnics acquired from, in particular, scientific publications, including the latest achievements in the field (EL3_W02);				
LO3	can formulate complex problems concerning mathematical modelling of electrical circuits, and effectively obtain the results of analysis (EL3_U02, EL3_U04);				
LO4	can identify and formulate complex tasks and problems related to the scientific discipline he/she represents, including problems leading to innovative technical solutions (EL3_U03);				

LO5	realises and feels the need for further education, for improving his/her professional and personal competence, and for analysing the latest achievements related to the scientific discipline they represent, including theory of electrical circuits and theory of analog signals (EL3_K01).

Basic references:	1. Wing O.: Classical circuit theory. Springer, New York, 2008. 2. Khalil H.K.: Nonlinear systems. Prentice-Hall, New Jersey, 1996. 3. Conte G., Moog C.H., Perdon A.M.: Algebraic methods for non-linear control systems. Springer, London, 2007. 4. Bolkowski S.: Teoria obwodów elektrycznych. WNT, Warszawa, 2013. 5. Osiowski J., Szabatin J.: Podstawy teorii obwodów. WNT, Warszawa, 2008. 6. Pasko M., Adrikowski T.:Elementy liniowych obwodów elektrycznych i elektronicznych: synteza układów pasywnych. Wydawnictwa Politechniki Śląskiej, Gliwice, 2009. 7. Pasko M. Dębowski K.: Symetryzacja układów trójfazowych i wielofazowych zasilanych ze źródeł napięć okresowych odkształconych. Wydawnictwa Politechniki Śląskiej, Gliwice, 2002. 8. Wilson R.J.: Wprowadzenie do teorii grafów. Wydawnictwa Naukowe PWN, Warszawa, 2004.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	oral and written exam;	L
LO2	oral and written exam;	L
LO3	oral and written exam;	L
LO4	oral and written exam;	L
LO5	oral and written exam.	L

Department:	Department of Theoretical Electrotechnics and Metrology	Tutors:	B. Butryło
Date:	30.12.2014	Coordinator:	**Bogusław Butryło, D.Sc., Ph.D.**

Faculty of Electrical Engineering						
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**	
Module name:	**Methodology of research**					
Module type:	**compulsory**	Semester: **1**		ECTS: **1**	Module ID:	**ES3D O11 03**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-					
Aims and objectives:	to familiarise students with the methodology of experiment design, analysis of measurement results and verification of scientific hypotheses; to acquaint students with the requirements concerning conducting research and creating research documentation; to acquaint them with the academic code of values; to acquaint them with copyright law.					
Assessment:	final written test.					
Module content:	Creating a research programme. Experiment, observation and induction as basic experimental research methods. Planning research. Methods of examination procedure. Determinants of creating hypotheses and modelling processes. Conditions of conducting experimental works. Principles of verifying the accuracy of experimental measurements. Measurement uncertainty. Patterns and calibration of measuring instruments. Measuring systems. Mathematical methods for the analysis of test results. Introduction to statistical methods in research. Direct measurements of measured quantity and indirect methods of measurement. Rules for creating technical and scientific documentation. Gathering documentation, development of results. Academic code of values and copyright law. Basic legislation in the field of health and safety at work. Dangerous, harmful and onerous factors in the human environment. Local and general lighting at the workplace. Working spaces. Fire protection in facilities. Procedure in the event of fire, the concept of escape route, methods and ways of fighting fires. Principles and methods of the first aid.					
Learning outcomes:	The student who has passed the module assessment:					
LO1	is versed in the basic experimental research methods (EL3_W03);					
LO2	knows the rules of verifying the accuracy of measurements and methods of their analysis (EL3_W03, EL3_U02);					
LO3	is able to plan the research programme, creates documentation of the research and develops its results (EL3_U05, EL3_U06);					
LO4	understands the need to comply with the academic code of values and to respect copyright (EL3_K02, EL3_K05).					

Basic references:	1. Chwaleba A., Poniński M., Siedlecki A.: Metrologia elektryczna. WNT, Warszawa, 2010. 2. Janiczek R.: Elektryczne miernictwo przemysłowe. Wydawnictwo Politechniki Częstochowskiej, 2006. 3. Dobre obyczaje w nauce. Zbiór zasad i wytycznych. Polska Akademia Nauk, Warszawa, 2001. 4. Jasiński A. (red.): Zarządzanie wynikami badań naukowych: poradnik dla innowatorów. Wydział Zarządzania Uniwersytetu Warszawskiego, Warszawa, 2011. 5. Korzyński M.: Metodyka eksperymentu: planowanie, realizacja i statystyczne opracowanie wyników eksperymentów technologicznych. WNT, Warszawa, 2006. 6. Weiner J.: Technika pisania i prezentowania prac naukowych. Kraków, 1992. 7. Wyrażanie niepewności pomiarowych - przewodnik. Wyd. GUM, Warszawa, 1999. 8. Kosmol J.: Wybrane zagadnienia metodologii badań. Wydawnictwo Politechniki Śląskiej, Gliwice, 2010. 9. Rączkowski B.: BHP w praktyce. ODDK, Gdańsk, 2010. 10. Celeda R.: Bezpieczeństwo i higiena pracy. ABC (Wolters Kluwer), Warszawa, 2010. 11. Augustyńska D.: Bezpieczeństwo i higiena pracy. Centralny Instytut Ochrony Pracy - Państwowy Instytut Badawczy, Warszawa, 2008. 12. Dołęgowski B., Janczała S.: Co pracownik powinien wiedzieć o BHP: podstawowe wiadomości o bezpieczeństwie pracy, zagrożeniach zawodowych, pierwszej pomocy i ochronie przeciwpożarowej. ODDK, Gdańsk, 2010. 13. Dahlke G., Górny A.: The ergonomics and safety in environment of human live. Poznan University of Technology, Poznań 2009. 14. Flick U.: Introducing research methodology: a beginner's guide to doing a research project. SAGE, e-book, 2011. 15. Kothari C. R.: Research Methodology: Methods and Techniques. New Age International, 2004. 16. Welman Ch., Kruger F., Mitchell B.: Research methodology. Oxford, Oxford University Press, 2005.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final written test, discussion at the lecture;	L
LO2	final written test, discussion at the lecture;	L
LO3	final written test, discussion at the lecture;	L
LO4	final written test, discussion at the lecture.	L

Department:	Department of Electrical Power Engineering, Photonics and Lighting Technology	Tutors:	J. Dorosz
Date:	30.12.2014	Coordinator:	**prof. Jan Dorosz**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**Didactics in higher education**				
Module type:	**compulsory**	Semester: **1**	ECTS: **3**	Module ID:	**ES3D O11 04**
Number of hours:	L - 30	E - 15	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to extend students' knowledge in the field of didactics in higher education, particularly concerning psychological, pedagogical and philosophical basis of the process of university education, different paradigms, factors affecting the process and outcomes achieved in the process; to help students develop skills of putting the acquired knowledge into practice in planning, implementing, controlling, and evaluating the course and outcomes of the learning process; to develop students' social competences, particularly to create the awareness of responsibility and ethical behaviour in the work with university students as well as to arise the need to improve teaching skills continuously.				
Assessment:	Written test – test and completion of practical assignments: defining objectives, designing a syllabus, preparing and presenting a class plan, designing tools for the assessment of learning outcomes. Attendance and active participation and involvement in classes.				
Module content:	1. Didactics as a science. Didactics in higher education – understanding and placing it in the system of sciences and main research trends (2 L). 2. Terminology of didactics: studying, teaching, learning, educating, self-education (2 L). 3. Theoretical context of learning process (psychological, pedagogical and philosophical basis) (2 L + 2E). 4. Process of academic education according to different paradigms (behaviourist, humanistic, constructivist, and critical-emancipationist) (2 L). 5. Styles of teaching and patterns of studying ((2 L). 6. Learning objectives, changes in educational methodology. Learning outcomes (2 L + 2 E). 7. National Qualifications Framework. Learning programme based on outcomes, study programme, study plan (2 L). 8. Teaching rules (2 L). 9. Learning methods (2 L + 2 E). 10. Organisational forms of learning (2 L). 11. Types of classes in higher schools (2 L). 12. Teaching resources and modern technologies in university education (2 L). 13. Evaluation of students' achievements/ assessment of learning outcomes (2 L + 2 E). 14. Participants of the learning process (students and academic teachers in different roles (2 L). 15. Communication in the learning process – creating an active studying environment. Motivating students to study (2 L). 16. Plan of teaching and educating work with students. Construction of syllabus (2 E). 17. Designing a teaching class (4 E). 18. Module assessment (1 E).				

Learning outcomes:	The student who has passed the module assessment:
LO1	possesses an extensive knowledge of the theoretical basis of the learning process, different paradigms of university education, participants of the education process, factors affecting the process (aims, contents, rules, methods, resources, organisational forms) and outcomes of the education process in higher school (EL3_W06);
LO2	knows the rules and methods of planning classes in the chosen subject of the specific field of education as well as the rules and methods of designing and conducting classes in the subject (EL3_U08);
LO3	can define learning objectives, design a syllabus of the chosen subject of the specific field of education, prepare and present a class plan in the chosen subject, prepare tools for the assessment of learning outcomes (EL3_UO8);
LO4	can select suitable methods, modern techniques, resources, organisational forms to create an active working environment for students (EL3_U07, EL3_U08);
LO5	is aware of responsibility and ethical behaviour in the work with students (EL3_K05);
LO6	has a need to continuously improve teaching skills in the work with students (EL3_K01, EL3_K04).

Basic references:

1. Bereźnicki F.: Zagadnienia dydaktyki szkoły wyższej. WSH TWP, Szczecin, 2009.
2. Denek K.: Uniwersytet w perspektywie społeczeństwa wiedzy. Dydaktyka akademicka i jej efekty. WSPiA, Poznań, 2011.
3. Jaskot K. W. (ed.): Wprowadzenie do pedagogiki szkoły wyższej. Oficyna IN PLUS, Szczecin, 2006.
4. Karpińska A., Wróblewska W. (ed.): Dylematy dydaktyki szkoły wyższej. Trans Humana, Białystok, 2008.
5. Kraśniewski A.: Proces Boloński – to już 10 lat. Fundacja Rozwoju Systemu Edukacji, Warszawa, 2009.
6. Kwieciński Z., Śliwerski B. (ed.): Pedagogika. Podręcznik akademicki, vol.1 i 2. Wydawnictwo Naukowe PWN, Warszawa, 2003.
7. Perspektywy rozwoju dydaktyki szkoły wyższej. Chapter in: A. Karpińska, W. Wróblewska (ed.): Kierunki rozwoju dydaktyki w dialogu i perspektywie. Difin, Warszawa, 2011.
8. Sajdak A., Paradygmaty kształcenia studentów i wspierania rozwoju nauczycieli akademickich. Teoretyczne podstawy dydaktyki akademickiej. OW Impuls, Kraków, 2013.
9. Wróblewska W.: Autoedukacja studentów w uniwersytecie – ujęcie z perspektywy podmiotu. Trans Humana, Białystok, 2008.
10. Wróblewska W.: Metody pracy ze studentami w kontekście efektów określonych w Krajowych Ramach Kwalifikacji dla Szkolnictwa Wyższego. E-mentor, no. 1 (43), 2012.
11. Barr R. B., Tagg J.: From teaching to learning. A new paradigm for undergraduate education (http://www.athens.edu/visitors/QEP/Barr_and_Tagg_article.pdf).
12. Hannan A., Silver H., Innovating in higher education. Teaching, learning and institutional culture. The Society for Research into Higher Educational & Open University Press, 2000. http://www.amazon.com/Innovation-Higher-Education-Teaching-Institutional/dp/0335205380

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written test;	L
LO2	written test;	L
LO3	completing practical assignments, defining learning objectives, designing a syllabus, preparing and presenting a class plan, designing tools for the assessment of learning outcomes;	E
LO4	an attempt to apply modern methods and techniques of activating students, a search for solutions motivating students to study;	E
LO5	conversation with students, observation of students' work and behaviour, students' self-assessment;	L + E
LO6	conversation with students, observation of students' attitudes, student's self-assessment.	L + E

Department:	University of Białystok, Faculty of Pedagogy and Psychology Department of General Didactics	Tutors:	Walentyna Wróblewska
Date:	15.12.2014	Coordinator:	**Walentyna Wróblewska, Ph.D.**

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Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Individual PhD research programme**				
Module type:	**compulsory**	Semester: **1 - 8**	ECTS: **1** (in each semester)	Module ID:	**ES3D O11 12** **ES3D O22 12** **ES3D O33 12** **ES3D O44 12** **ES3D O55 12** **ES3D O66 12** **ES3D O77 12** **ES3D O88 12**
Number of hours:	L - 0	E - 0	LC - 0	P - 0	SW - 0 S – 0
Prerequisites:	-				
Aims and objectives:	to initiate and progress a PhD; to complete all requirements for the PhD thesis; to complete scientific achievements to get a PhD degree in electrotechnics.				
Assessment:	The assessment of progress and fulfilment of the individual research programme during a semester is made by student's supervisor.				
Module content:	Within the individual PhD research programme a student achieves an advanced and theoretically-based knowledge of: - the field of conducted research; - the methodology of conducted research; - ethics and legal aspects related to scientific work; - methods of preparation of scientific articles and presentation of research results; - aspects related to implementation and commercialisation of scientific work. A PhD student acquires skills to integrate the knowledge from different sources, to formulate and resolve complex tasks and problems from his/her scientific discipline. A PhD student develops competences of thinking and performing in an independent and creative way. The final result is defending a PhD thesis.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	have a well-grounded theoretically-based knowledge in the area of their research (coming mainly from scientific publications), including the latest scientific achievements (EL3_W02);				
LO2	have the knowledge of the methodology of conducting scientific research, and of legal and ethical aspects of scientific work (including methods of preparing a publication and presentation of research results) (EL3_W03);				
LO3	have a basic knowledge of obtaining and conducting research projects, including economic and legal aspects of project development (EL3_W04);				

LO4	have a basic knowledge concerning transfer as well as commercialisation of research results, especially of issues regarding intellectual property protection (EL3_W05);
LO5	can effectively acquire information (connected with their scientific work) from different sources, also in foreign languages and select and interpret in an appropriate way (EL3_U01);
LO6	can critically evaluate results of both their own and other people's research and other creative work as well as their contribution to the development of the discipline they represent, using the acquired knowledge; in particular, graduates can assess the usefulness and possibility of applying the results of theoretical work in practice (EL3_U02);
LO7	can identify and formulate complex tasks and problems related to the scientific discipline they represent, including conceptually new tasks and research problems leading to innovative technical solutions (EL3_U03);
LO8	can solve complex tasks and problems connected with the scientific discipline they represent (including non-standard tasks) using conceptually new methods contributing to the development of knowledge, or innovative solutions of practical value, whose level of originality justifies their publication in reviewed scientific journals (EL3_U04);
LO9	can plan and implement, in a methodologically correct way, their own research projects related to scientific work conducted in bigger teams (EL3_U05);
LO10	can prepare documentation of research work results as well as scientific publications, also in a foreign language, according to the principles of developing such publications, with particular attention to the copyright law (EL3_U06);
LO11	can communicate efficiently in an international scientific and professional environment, using different technologies, also in a foreign language; graduates have the ability to present their achievements and ideas in an understandable way, and to use appropriate arguments in scientific discussions (EL3_U07);
LO12	realise and feel the need for further education, for improving their professional and personal competence, and for analysing the latest achievements related to the scientific discipline they represent (EL3_K01);
LO13	realise the importance of behaving in a professional way, adhering to the principles of professional ethics, and developing the ethos of their scientific and professional environment (EL3_K02);
LO14	can think and work in an independent and creative way; graduates are active to generate new ideas, seek innovative solutions, and determine new areas of research (EL3_K03);
LO15	are aware of the social role of graduates of third-cycle courses, and understand the need to communicate to the society information and opinions concerning scientific and technological achievements (EL3_K05).
Basic references:	References are selected according to the scope of individual scientific programme.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	contact with the student's advisor, resolving partial problems during work on the PhD thesis, reviews of PhD student's publications, PhD exams, reviewers' evaluation of the PhD thesis;	-
LO2	contact with the student's advisor, supervision of the head of the organisational unit in which the work is performed, reviews of PhD student's publications, discussions during PhD seminaries;	-
LO3	contact with the student's advisor, supervision of the head of the organisational unit, preparation of applications for funds for one's own research work and grants;	-
LO4	contact with the student's advisor, supervision of the head of the organisational unit;	-
LO5	contact with the student's advisor, reviews of PhD student's publications, PhD exams, reviewers' evaluation of the PhD thesis;	-
LO6	contact with the student's advisor, reviews of PhD student's publications, PhD exams, reviewers' evaluation of the PhD thesis;	-
LO7	contact with the student's advisor, reviews of PhD student's publications, PhD exams, reviewers' evaluation of the PhD thesis;	-
LO8	contact with the student's advisor, reviews of PhD student's publications, PhD exams, reviewers' evaluation of the PhD thesis;	-
LO9	contact with the student's advisor, supervision of the head of the organisational unit, preparation of applications for funds for one's own research work and grants;	-
LO10	contact with the student's advisor, reviews of PhD student's publications, PhD exams, reviewers' evaluation of the PhD thesis;	-
LO11	contact with the student's advisor, supervision of the head of the unit, reviews of PhD student's publications;	-
LO12	contact with the student's advisor, supervision of a head of organisational unit;	-
LO13	contact with the student's advisor, reviews of PhD student's publications, PhD exams, reviewers' evaluation of the PhD thesis;	-
LO14	personal contact with a scientific worker, supervision of the head of organisational the unit, reviews of PhD student's publications, reviewers' evaluation of the PhD thesis;	-
LO15	contact with the student's advisor, supervision of the head of the organisational unit.	-

Department:	Coordinator of the doctoral programme, Personal supervisor of the scientific programme	Tutors:	Personal supervisor of the scientific programme
Date:	11.12.2014	Coordinator:	**Ewa Świercz, D.Sc., Ph.D.**

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Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Automatic control theory**				
Module type:	**compulsory**	Semester: **2**	ECTS: **2**	Module ID:	**ES3D O22 01**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to present basic knowledge concerning the modern theory of dynamical systems control.				
Assessment:	written exam;				
Module content:	Description of generalised continuous-time and discrete-time linear and non-linear systems. Determination of solutions to generalised linear systems using Drazin inverse matrix method. Reachability and control ability of generalised linear systems. Observability and recontractability of generalised linear systems. Realisation problem for standard and singular multi-dimensional systems. Determination of minimal realisations. Computations of realisations in singular linear systems. A-invariant spaces and (A, B) -invariant spaces of linear systems. Determination (computation) of (A, B) invariant spaces of linear systems. Geometrical approach to the analysis of linear systems. Lee Brackets, the distribution of vector field in linear systems. Linearisation of non-linear systems with the use of non-linear feedback. Examples of applications of geometrical approach to the analysis and synthesis of linear and non-linear systems. Introduction to the theory of fractional linear systems and to positive fractional linear systems.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has a good knowledge concerning the modern theory of automatic control systems;				
LO2	is well versed in selected aspects of advance modern methods for the analysis of automatic control systems.				
LO3	is able to apply the modern automatic control system theory for the design of automatic control systems and in the analysis and research of automatic control systems;				
LO4	recognises the need for self-learning and development in the field of modern automatic control with the aim of applying the theory to solve practical problems.				

Basic references:	1. Kaczorek T.: Theory of control systems. Wydawnictwo Naukowe PWN, Warszawa, 1997 (in Polish). 2. Kaczorek T., Dzieliński A., Dąbrowski W., Łopatka R.: Principles of control theory systems. Wydawnictwo WNT, Warszawa, 2004. 3. Isidori A.: Nonlinear control systems. Springer-Verlang, Berlin, 1995. 4. Kaczorek T.: Polynomial and rational matrices. Springer-Verlang, London, 2007. 5. Kaczorek T.: Selected problems of fractional systems theory. Springer-Verlang, Berlin 2011. 6. Kaczorek T., Sajewski Ł.: The realisation problem for positive and fractional systems. Springer-Verlang, 2014. 7. Kaczorek T., Rogowski K.: Fractional linear systems and electrical circuits. Springer-Verlang, 2014.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	examination, written form;	L
LO2	examination, written form;	L
LO3	observation and discussion during classes;	L
LO4	observation and discussion during classes.	L

Department:	Department of Automatic Control and Electronics	Tutors:	T. Kaczorek
Date:	30.12.2014	Coordinator:	**prof. Tadeusz Kaczorek**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Optoelectronic systems**				
Module type:	**compulsory**	Semester: **2**	ECTS: **2**	Module ID:	**ES3D O22 02**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to acquaint students with selected issues of optoelectronic metrology; to teach the methods of the analysis of electromagnetic radiation in planar waveguides; to acquaint students with the properties, technology and materials used in integrated optics; to teach the principles of operation of modulators, couplers and amplifiers in the integrated technology; to acquaint students with the conditions for the formation of non-linear effects in optical integrated systems and the possibility of their use in measuring and medical technology; to acquaint students with the prospects of optoelectronic systems.				
Assessment:	final exam.				
Module content:	Selected issues in optoelectronic metrology. Propagation of electromagnetic radiation in planar waveguides. Monocrystalline and polycrystalline materials used in integrated optics – properties, technology (CVD, sol-gel, ion exchange, epitaxy), sample applications (modulators, couplers, amplifiers). Micro-electromechanical 2D and 3D structures (MEMS). Nonlinear phenomena occurring in the waveguides and their use in measuring and medical technology. Prospects for the development of optoelectronic systems.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has theoretical knowledge about selected methods of modern control theory (EL3_W01);				
LO2	describes properties and technology of manufacturing materials used in integrated optics (EL3_W02);				
LO3	efficiently obtains information and discusses issues related to modulators, couplers and amplifiers in the integrated technology, as well as transmitters and optical radiation detectors (EL3_U01);				
LO4	understands the necessity of continuous learning, improving professional and personal competence and analysing the latest developments in his/her scientific discipline (EL3_K01);				
LO5	indicates prospectus for the development of optoelectronic systems (EL3_K03).				

Basic references:	1. Safa Kasap, Harry Ruda, Yann Boucher, Cambridge Illustrated Handbook of Optoelectronics and Photonics, Cambridge University Press, 2012. 2. Maurice Quillec, Materials for Optoelectronics, Springer; 1996. 3. John M. Senior: Optical Fiber Communications Principles and Practice, Pearson Education Limited 2009. 4. Safa O. Kasap: Optoelectronics and Photonics: Principles and Practices, Prentice Hall, 2001. 5. Olaf Karthaus, Biomimetics in Photonics, Series in Optics and Optoelectronics, CRC Press, 2012. 6. Fenglian Bai, Xiong Gong, Xiaowei Zhan, Hongbing Fu, Thomas Bjornholm, Organic Optoelectronics, John Wiley & Sons, 2013.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final written test;	L
LO2	final written test;	L
LO3	observation and discussion at the lectures;	L
LO4	final written test;	L
LO5	final written test.	L

Department:	Department of Electrical Power Engineering, Photonics and Lighting Technology	Tutors:	J. Dorosz
Date:	30.12.2014	Coordinator:	**prof. Jan Dorosz**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**PhD seminar**				
Module type:	**compulsory**	Semester: **2, 4, 6, 8**	ECTS: **1** (in each year)	Module ID:	**ES3D O22 10, ES3D O44 10, ES3D O66 10, ES3D O88 10**
Number of hours:	L - 0	E - 0	LC - 0	P - 0	SW - 0	S – 15
Prerequisites:	-					
Aims and objectives:	to acquaint PhD students with Polish rules concerning doctoral process, preparing a PhD thesis, copyright; to consult the current stage of students' research; to assess the current progress of students' research; to enable discussion among PhD students provoked by students' presentations.				
Assessment:	Assessment with grade based on students' oral presentation.				
Module content:	Presentation of Polish regulations concerning the PhD process including procedures at the Electrical Faculty of Bialystok University of Technology. Describing general principles of writing a PhD thesis with special attention paid to copyright. Presentations by PhD students concerning the current stage of their research and the PhD thesis. Tutor's comments and remarks after the presentations.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has knowledge of the methodology of scientific research, as well as the legal and ethical aspects of research, including the methods of preparing a publication and presentation of research results (EL3_W03);				
LO2	can effectively acquire information (connected with their scientific work) from different sources, also in foreign languages, and select and interpret it in an appropriate way (EL3_U01);				
LO3	can, using the acquired knowledge, critically evaluate results of research and other creative work (EL3_U02);				
LO4	realises and feels the need for further education, for improving their professional and personal competence, and for analysing the latest achievements related to the scientific discipline they represent (EL3_K01);				
LO5	can prepare documentation of research work results as well as scientific publications, also in a foreign language, according to the principles of developing such publications, with particular attention to the copyright law (EL3_U06, EL3_U07);				

Basic references:	1. Procedure of writing a PhD at the Faculty of Electrical Engineering of Bialystok University of Technology available in the office of the doctoral programme and on the faculty's website. 2. The Act on Copyright and Related Rights. Full text available in *Monitor Polski* and on the websites of the Sejm. 3. Dobre obyczaje w nauce. Zbiór zasad i wytycznych. Polska Akademia Nauk, Warszawa, 2001. 4. Gambarelli G., Łucki Z.: Jak przygotować pracę dyplomową lub doktorską. Kraków, 1998.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	assessment of the quality of multimedia presentations concerning the subject matter of the dissertation;	S
LO2	assessment of the quality of the multimedia presentation concerning the subject matter of the dissertation;	S
LO3	assessment of the quality of the multimedia presentation concerning the subject matter of the dissertation;	S
LO4	assessment of the quality of the multimedia presentation concerning the subject matter of the dissertation;	S
LO5	assessment of the quality of the multimedia presentation concerning the subject matter of the dissertation.	S

Department:	Coordinator of the doctoral programme	Tutors:	Coordinator of the doctoral programme, Heads of departments within the Faculty of Electrical Engineering
Date:	11.12.2014	Coordinator:	**Ewa Świercz, D.Sc., Ph.D.**

Faculty of Electrical Engineering				
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**
Module name:	**Teaching practice – conducting or participating in university classes**			
Module type:	**compulsory**	Semester: **2, 4, 6, 8**	ECTS: **1** (in each year)	Module ID: **ES3D O22 11, ES3D O44 11, ES3D O66 11, ES3D O88 11**
Number of hours:	Conducting or participating in university classes (E – exercises, L – laboratory, P – project, SW – specialisation workshop) should take minimum15 hours during a year. Additionally, the classes must fulfil the Electrical Engineering Faculty's internal regulations adopted annually.			
Prerequisites:	Didactics in higher education.			
Aims and objectives:	to allow PhD students to be in the role of an academic teacher by conducting or participating in university classes.			
Assessment:	The coordinator of the PhD programme evaluates students' performance in the module at the end of an academic year.			
Module content:	During the course a PhD student achieves skills to use modern methods and techniques for teaching technical courses. A PhD student has to conduct independently 15 hours in all of the selected forms of courses: class, laboratory, project, and specialisation workshop. A PhD student can also conduct lectures under the supervision of his/her scientific supervisor. The content of conducted classes should be consistent with the curricula of the first and second degree studies at the Faculty.			
Learning outcomes:	The student who has passed the module assessment:			
LO1	has knowledge in the area of methodology and modern techniques of conducting classes (EL3_W06);			
LO2	is prepared for conducting classes with the aid of technology in a methodologically correct manner (EL3_U08);			
LO3	realises and feels the need for further education, for improving their professional and personal competence, and for analysing the latest achievements related to the scientific discipline they represent (EL3_K01);			
LO4	realises the importance of behaving in a professional way, adhering to the principles of professional ethics, and developing the ethos of his/her scientific and professional environment (EL3_K02);			
LO5	understands and feels the need to engage in the training of professionals in the engineering discipline he/she represents and in other activities leading to the development of a knowledge-based society (EL3_K04);			
LO6	is aware of the social role of graduates of third-cycle courses, and understands the need to communicate to the society information and opinions concerning scientific and technological achievements (EL3_K05).			
Basic references:	Literature - relevant to taught subjects and the methodology of corresponding classes.			

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	inspection of students' classes, contact with the coordinator of the PhD programme and the scientific supervisor, duty hours in didactic groups, participation in seminars connected with periodical assessment of didactic results;	-
LO2	inspection of students' classes, contact with the coordinator of the PhD programme and the scientific supervisor, duty hours in didactic groups, participation in seminars connected with periodical assessment of didactic results;	-
LO3	inspection of students' classes, contact with the coordinator of the PhD programme and the scientific supervisor, duty hours in didactic groups, participation in seminars connected with periodical assessment of didactic results;	-
LO4	inspection of students' classes, personal contact with the coordinator of the PhD programme, and with the scientific supervisor, duty hours in didactic groups, participation in departments' seminars connected with periodical assessment of didactic results;	-
LO5	inspection of students' classes, contact with the coordinator of the PhD programme and the scientific supervisor, duty hours in didactic groups, participation in seminars connected with periodical assessment of didactic results;	-
LO6	inspection of students' classes, contact with coordinator of the PhD programme and the scientific supervisor, duty hours in didactic groups, participation in seminars connected with periodical assessment of didactic results.	-

Department:	Coordinator of the doctoral programme	Tutors:	Coordinator of the doctoral programme, Heads of departments within the Faculty of Electrical Engineering, Personal supervisor of the scientific programme
Date:	11.12.2014	Coordinator:	**Ewa Świercz, D.Sc., Ph.D.**

Faculty of Electrical Engineering						
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**	
Module name:	**Powering systems of electric and electronic devices**					
Module type:	**compulsory**	Semester: **3**		ECTS: **2**	Module ID:	**ES3D O33 01**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-					
Aims and objectives:	To familiarise students with power converters - schemes, control methods, characteristics and parameters; to familiarise students with magnetic devices (transformers, inductors) operated with high frequency nonsinusoidal waveforms; to familiarise students with basic equations useful for the design of powering systems and the estimation of their parameters.					
Assessment:	Oral or written exam.					
Module content:	Kinds, characteristics and parameters of basic powering systems; current sources and voltage sources; multiple energy conversion systems with low and high conversion frequency; galvanic isolation in power and control systems; high frequency transformers and inductors - core loss for non sinusoidal excitation, winding copper loss increase due to skin and proximity effect; methods of transformer and inductor design; powering systems with battery stack and super capacitors as energy storage elements; converter systems with bi-directional power flow; the influence of converters on power grid. uni- and bi-directional power correction PFC systems; electromagnetic compatibility.					
Learning outcomes:	The student who has passed the module assessment:					
LO1	has basic knowledge concerning the construction and characteristics of powering systems (EL3_WO1);					
LO2	has theoretical knowledge concerning powering systems as presented in scientific publications (EL3_WO2);					
LO3	can gain information concerning the subject matter derived from various sources, also in foreign languages (EL3_UO1);					
LO4	understands and feels the need for increasing his or her competence concerning new developments in the subject matter (EL3_KO1).					
Basic references:	1. R. W. Erickson, D. Maksimović: Fundamentals of power electronics. Second Edition.Kluwer Academic Publisher, 2001. 2. M. Knapczyk, K. Pieńkowski: Analysis of pulse width modulation techniques for AC/DC line-side converters. Prace Naukowe Instytutu MniPE Politechniki Wrocławskiej. Nr. 59, 2006. 3. A. Bosshe, V. C. Valchev: Inductors and transformers for power electronics. Taylor & Francis, 2005. 4. R. Petkov: Optimum design of a high power, high frequency transformer. IEEE Trans. on Power Electron., vol. 11., no 1, 1996. 5. B. Zhao, Q. Yu, W. Sem: Extended phase-shift control of isolated bi-directional DC-DC converter for power distribution in microgrid. IEEE Trans. on Power Electron., vol. 27. no 11, 2012. 6. M. M. Jovanovic, D. C. Hopkins, F. C. Lee: Evalution and design of megahertz – frequency off-line zero-current-switched quasi resonant converters. IEEE Trans. on Power Electron., vol. 4. no 1, 1989.					

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	oral or written exam;	L
LO2	oral or written exam;	L
LO3	oral or written exam;	L
LO4	oral or written exam.	L

Department:	Department of Power Electronics and Electric Drives	Tutors:	T. Citko
Date:	16.12.2014	Coordinator:	**prof. Tadeusz Citko**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Theory and application of discrete systems**				
Module type:	**compulsory**	Semester: **3**	ECTS: **1**	Module ID:	**ES3D O33 02**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	Advanced topics of theoretical electrotechnics.				
Aims and objectives:	to introduce students to the theory and applications of discrete circuits and systems.				
Assessment:	examination.				
Module content:	Digital signal processing in automatic control systems. Mathematical description of discrete signals. The sampling theorem. Examples of system designs with the use of DSP. Z-transform and DFT. Methods of digital filters design. Stability and accuracy of digital filters. Discrete stochastic systems. Basics of the correlation theory of stochastic processes. Mathematical models of noise and interference measurement. The main principles of stochastic processes: filtering and estimation. Wavelet and time-frequency transformations. Examples of discrete system designs in industry and their development.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has an advanced knowledge of the basic issues concerning the scientific area and discipline (disciplines) related to the area of their research (EL3_W01);				
LO2	can effectively acquire information (connected with their scientific work) from different sources, also in foreign languages; graduates can select and interpret this information in an appropriate way (EL3_U01);				
LO3	can critically evaluate results of both their own and other people's research and other creative work as well as their contribution to the development of the discipline they represent, using the acquired knowledge; in particular, graduates can assess the usefulness and possibility of applying results of theoretical work in practice (EL3_U02);				
LO4	realises and feels the need for further education, for improving his/her professional and personal competence, and for analysing the latest achievements related to the scientific discipline they represent (EL3_K01).				
Basic references:	1. Lai I. E.: Practical digital signal processing for engineers and technicians. Elsevier, Amsterdam, 2003. 2. Roberts M.J.: Fundamentals of signals and systems. McGraw-Hill, Boston, 2008. 3. Proakis J.G., Manolakis D.G.: Digital signal processing: principles, algorithms, and applications. Prentice Hall, New York, 2007. 4. Smith S.K.: Digital signal processing - a practical guide for engineers and scientists. Elsevier Science, 2003, (http://www.dspguide.com/pdfbook.htm).				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written exam;	L
LO2	written exam;	L
LO3	written exam;	L
LO4	written exam.	L

Department:	Department of Telecommunications and Electronic Equipment	Tutors:	J. Griszin
Date:	30.01.2015	Coordinator:	**prof. Jurij Griszin**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Approximate solution methods in technical electrodynamics**				
Module type:	**compulsory**	Semester: **3**	ECTS: **1**	Module ID:	**ES3D O33 03**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	Mathematics				
Aims and objectives:	to familiarise the students with approximate methods for solving contemporary problems of technical electrodynamics; to ensure that students acquire skills in the application of these methods with the use of symbolic computation software; to acquaint students with the mathematical foundations of popular numerical methods.				
Assessment:	written homework and oral summary of homework's results; final oral assessment.				
Module content:	Essential concepts of functional analysis as the theoretical basis of the discussed approximate methods: Banach spaces, linear operators, Hilbert spaces. Methods of weighted residuals: point collocation, subdomain collocation, least squares, and Galerkin methods. The energy functional. The Ritz variational method. Generalisation of information on approximate solution methods. Strong and weak formulation. General classification of approximate methods. The Trefftz method. Solving example problems using Maxima – computer symbolic computation software. Writing simple procedures for the application of the learned methods – homework.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has advanced knowledge of the fundamentals of technical electrodynamics (EL3_W01);				
LO2	has detailed theoretical knowledge concerning the approximate methods of technical electrodynamics, derived, in particular, from scientific publications, including the latest science achievements (EL3_W02);				
LO3	can effectively acquire information related to technical electrodynamics from various sources, also in foreign languages, and make the appropriate selection and interpretation of this information (EL3_U01);				
LO4	can solve tasks of technical electrodynamics using approximate methods (EL3_U04);				
LO5	understands the necessity of lifelong learning, improving professional skills, and analysing the latest developments related to technical electrodynamics (EL3_K01).				

Basic references:	1. Bathe K. J.: Finite element procedures. Prentice-Hall, 1996. 2. Harrington R. F.: Field computation by moment methods. New York, IEEE Press, 1993. 3. Reddy J. N.: Energy principles and variational methods in applied mechanics. J. Wiley & Sons, 2002. 4. Zienkiewicz O. C., Morgan K.: Finite elements and approximation. Dover Publications, 2006. 5. Aniserowicz K.: Comparison of different numerical methods for solving boundary-value problems in electromagnetics. IEEE Transactions on Education, vol. 47, no. 2, pp. 241-246, 2004. 6. The Internet site of Maxima, the symbolic computation software.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	homework completion, ongoing control;	L
LO2	homework completion, ongoing control;	L
LO3	homework completion, ongoing control;	L
LO4	homework completion, ongoing control;	L
LO5	homework completion, ongoing control.	L

Department:	Department of Telecommunications and Electronic Equipment	Tutors:	K. Aniserowicz
Date:	11.12.2014	Coordinator:	**prof. Karol Aniserowicz**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**English**				
Module type:	**compulsory**	Semester: **7**	ECTS: **1**	Module ID:	**ES3D O77 01**
Number of hours:	L - 0	E - 15	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	Developing reading and listening skills in English in order to access and interpret the materials necessary in conducting research, teaching students and taking a doctoral exam in English. Acquiring competences necessary to follow discussions with foreign colleagues, describe research and write scientific papers, summaries and abstracts.				
Assessment:	Graded credit: a term paper (an introduction to a scientific article, a summary or an abstract), a multimedia presentation, a final test.				
Module content:	An overview of writing in the sciences. Writing an introduction, a summary or an abstract of a scientific article. Giving a multimedia presentation. Language functions at a meeting/conference: expressing opinions, agreeing, disagreeing, making suggestions, socialising. Presenting papers at a conference. English for specific purposes – technical vocabulary and word phrases connected with Electrotechnics. Suffixes and prefixes in technical English, compound nouns. Word formation and word families – verbs, adjectives, adverbs, agent and abstract nouns. Collocations in technical English. Academic English. Technical English vocabulary of Greek and Latin origin. Grammar issues – active and passive voice, strong verbs. English-Polish and Polish-English translations of scientific papers. Profiles, organising CVs and cover letters, planning a career path, applying for a job.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	knows technical vocabulary and word phrases connected with the specialisation, and understands very well scientific papers written in English (EL3_U01, EL3_U07);				
LO2	is able to write an introduction, summary, abstract of a scientific paper and make a presentation (EL3_U06, ELU_07);				
LO3	knows grammar used in scientific papers (EL3_U01, EL3_K01);				
LO4	translates Polish to English and vice versa (EL3_U07, EL3_K02, EL3_K05).				

Basic references:	1. Macpherson R.: English for Academic Purposes. PWN, Warszawa, 2007. 2. McCarthy M.: Academic vocabulary in use. Cambridge University Press, Cambridge, 2008. 3. Bonamy D.: Technical English 3. Longman-Pearson Education, Essex, 2008. 4. Armer T.: Cambridge English for Scientists. Cambridge University Press, Cambridge, 2012. 5. Ibbotson M.: Cambridge English for Engineering. Cambridge University Press, Cambridge, 2008. 6. Hewings M., Thaine C.: Cambridge Academic English, Cambridge University Press, Cambridge, 2008. 7. MacKenzie I.: Professional English in Use: Engineering. Cambridge University Press, Cambridge, 2009. 8. Burton G.: Presenting. Deliver presentations with confidence. HarperCollins Publishers, London, 2013. 9. Chadaj S.: Język angielski zawodowy w branży elektronicznej, informatycznej i elektrycznej. WSiP, Warszawa, 2013. 10. Śleszyńska M.: Get Ready for Technical B2. Politechnika Białostocka, Białystok, 2011. 11. http://online.stanford.edu/Writing_in_the_Sciences_Fall_2014 12. www.uefap.com 13. Specialist and technical dictionaries e.g. www.tech-dict.pl, http://pl.glosbe.com http://megaslownik.pl.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	technical and academic vocabulary test, discussions;	E
LO2	an introduction, abstract or a summary to a scientific paper; a PowerPoint presentation;	E
LO3	a grammar test;	E
LO4	oral and written translations of scientific materials.	E

Department:	Foreign Languages Centre	Tutors:	M. Śleszyńska
Date:	30.12.2014	Coordinator:	**Monika Śleszyńska, M.Sc.**

4. Syllabuses of optional modules

The general programme, basic references and some requirements of optional modules are described on the following pages.

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Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Modern trends in university teaching**				
Module type:	**optional**	Semester: **2**	ECTS: **2**	Module ID:	**ES3D W22 01**
Number of hours:	L - 15	E - 15	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	Didactics in higher education				
Aims and objectives:	to acquaint students with advanced knowledge of contemporary trends in university teaching, including the sources of the occurring changes, their complexity, determinants and significance for high school education; to develop students' ability to use the acquired knowledge regarding the improvement of quality of education in practice – forming subjective relations in the education process, using self-regulatory processes in academic learning, evaluating teacher's work by the teacher and by the students, the use of tutoring in academic education; to develop students' social competencies – the sense of responsibility in working with university students, the need to inspire and support the students' learning process and the need of constant didactic and professional improvement.				
Assessment:	Oral, on the basis of activity in discussions during the classes, execution of practical tasks and class attendance.				
Module content:	1. Sources of changes in university teaching – the philosophical, economic and social context. Mass availability of education. Changes in the mission and function of universities and high schools (2 lectures + 1 class). 2. Theoretical concepts of the quality of education at a high school versus the practice of education (2 lectures + 2 classes). 3. Changes in the objective and subjective components of the education system. The role of a university teacher. Didactic cooperation of teachers and students. The responsibilities of teachers and students; students' activity, autonomy and subjectivity (2 lectures + 2 classes). 4. Self-regulation in the academic learning process – the essence, phases and processes, research results. Opportunities for the development of self-regulation processes (2 lectures + 1 class). 5. Control and assessment in the education process – aims, methods, forms and characteristics. Assessment criteria. Students' activity and autonomy in the process of control and assessment (2 lectures + 1 class). 6. Teacher's self-evaluation – feedback and reflection in the education process – sources, types, effectiveness (2 lectures + 2 classes). 7. Student evaluation of teacher's work (2 classes). 8. Academic tutoring – the essence, theoretical basis, possibilities and limitations of application in Polish higher education (2 lectures + 1 class). 9. Accreditation – ensuring the quality of teaching in higher education – the term, aims, procedure, principles and importance (1 lecture + 1 class). 10. Module assessment (2 classes).				

Learning outcomes:	The student who has passed the module assessment:
LO1	has advanced knowledge of changes in academic teaching, their sources, complexity, determinants and significance for the quality of education in a high school (EL3_W06);
LO2	has advanced knowledge concerning the possibilities of improving the quality of their own and students' work, the need of cooperation between teachers and students, the importance of self-regulation in the academic learning process, self-evaluation and evaluating students' work, and the use of accreditation procedures at high schools (EL3_W06);
LO3	is able to involve students in the control and assessment process, uses self-assessment and peer assessment (EL3_U08, EL3_K04);
LO4	is able to evaluate his/her own work and use student evaluation of teacher's work (EL3_U08);
LO5	is aware of the responsibility in the work with students and the need of constant didactic and professional improvement (EL3_K05);
LO6	is aware of the need to inspire and support the students' learning process (EL3_K04, EL3_K05).

Basic references:

1. Denek K.: Uniwersytet w perspektywie społeczeństwa wiedzy. Dydaktyka akademicka i jej efekty. Wyższa Szkoła Pedagogiki i Administracji im. Mieszka I, Poznań, 2011.
2. Hejwosz D., Edukacja uniwersytecka i kreowanie elit społecznych. Oficyna Wydawnicza „Impuls", Kraków, 2010.
3. Jaskot K., (ed.): Wprowadzenie do pedagogiki szkoły wyższej. Oficyna IN PLUS, Szczecin, 2006.
4. Kostkiewicz J., Domagała-Kręcioch A., Szymański M. (ed.): Szkoła wyższa w toku zmian. Oficyna Wydawnicza „Impuls", Kraków, 2011.
5. Krajewska A.: Jakość kształcenia uniwersyteckiego – ujęcie pedagogiczne. Trans Humana, Białystok, 2004.
6. Sajdak A.: Paradygmaty kształcenia studentów i wspierania rozwoju nauczycieli akademickich; Teoretyczne podstawy dydaktyki akademickiej. Oficyna Wydawnicza „Impuls", Kraków 2013.
7. Krajewska A., Kowalczuk-Walędziak M.: Possibilities and limitations of the application of academic tutoring in Poland. "Higher Education Studies" 2014, Vol. 4, No. 3, s. 9–18; Canadian Center of Science and Education, http: www.ccsenet.org/journal/index.php/.../2096.
8. Fry H., Ketteridge S., Marshall S.: A handbook for teaching & learning in higher education. London and New York, 2009, http: biblioteca.ucv.cl.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	oral test, discussion;	L, C
LO2	oral test, discussion;	L, C
LO3	designing a didactic situation in which students actively participate in control and assessment;	C
LO4	designing a tool for teacher's self-evaluation;	C
LO5	discussion with the students, identifying one's strengths and weaknesses as a university teacher;	C
LO6	students presenting their own ideas concerning the improvement of students' learning process.	C

Department:	University of Białystok, Faculty of Pedagogy and Psychology, Department of General Pedagogy and Methodology of Research in Pedagogy	Tutors:	A. Krajewska
Date:	10.12.2014	Coordinator:	**Anna Krajewska, Ph.D.**

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Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Modern information methods and techniques in teaching**				
Module type:	**optional**	Semester: **2**	ECTS: **1**	Module ID:	**ES3D W22 02**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	Didactics in higher education				
Aims and objectives:	to acquaint students with the principles of use of electronic tools of teaching and information technology in education; to help students acquire skills of planning teaching with the use of modern methods, information techniques and electronic didactic tools.				
Assessment:	oral or written assessment with a mark.				
Module content:	Characteristics of education assisted by modern technologies. Psychological and pedagogical aspects of using multimedia in education. Educational software - general characteristics. Criteria for the evaluation of the educational usefulness of software. Function of multimedia presentations in education. Creating multimedia didactic materials – multimedia techniques and methodological principles. Planning classes with the use of information technology. Creative activity of students working with computers in class – how to arouse it? Technologically supported education - implications for teaching. Distance education: e-teacher, e-student, e-methodology.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has knowledge in the area of methodology and modern techniques of conducting classes (EL3_W06);				
LO2	is prepared for conducting classes with the aid of technology in a methodologically correct manner (EL3_U08);				
LO3	understands and feels the need of continuous training in the field of modern technologies in didactic work (EL3_K01).				
Basic references:	1. Żylińska M.: Neurodidactics. Teaching and Learning Friendly to a Brain. Scientific Publisher University of Nicolae Copernicus, Torun, 2013. 2. Juszczyk S.: Distance Education. Codification of the Concepts, Principles and processes. Publisher Adam Marszałek, Torun, 2002. 3. Tanaś M. (red): Information Technology in Didactics. Publisher Mikom, Warsaw, 2005. 4. Educational technologies – tradition, the present day, foreseeable future. Publisher Adam Marszałek, Torun, 2011. 5. E-mentor (journal), www.e-mentor.edu.pl 6. Baron-Polańczyk E. (ed.): ICT in educational design : processes, materials, resources. Vol.1-4, Oficyna Wydawnicza Uniwersytetu Zielonogórskiego, Zielona Góra, 2012 - 2013. 7. Runiewicz-Wardyn M.: Towards building an elearning environment in Poland. Wydawnictwa Akademickie i Profesjonalne, Kozminski Business School, Warszawa, 2008. 8. Kiełtyka L. (ed.): IT tools in management and education : selected problems. Czestochowa University of Technology, 2011.				

	Methods of assessing a learning outcome:			Type of class where the outcomes are assessed
LO1	written test concerning theoretical aspects of using ICT in education;			L
LO2	creating a lesson plan on a selected topic making use of modern techniques of teaching;			L
LO3	analysis of literature and other sources in the field of modern didactic techniques in academic education.			L
Department:	University of Bialystok, Faculty of Mathematics and Informatics	Tutors:	A. Rybak	
Date:	18.12.2014	Coordinator:	**Anna Rybak, Ph.D.**	

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**Basics of self-presentation**				
Module type:	**optional**	Semester: **2**	ECTS: **1**	Module ID:	**ES3D W22 03**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0 S – 0
Prerequisites:	-				
Aims and objectives:	to draw students' attention to the practical aspects of the presentation of research results; to teach the skills of communicating information with the use of a poster and other presentation forms.				
Assessment:	Assessment based on the evaluation of a presentation with the use of multimedia or a poster and students' participation in class discussions.				
Module content:	How to prepare a good presentation? Using software to transfer information. The art of poster design. Verbal and non verbal communication.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	can assess the role of a well-prepared oral presentation (EL3_W03);				
LO2	is able to make a good presentation with the use of multimedia (EL3_W03);				
LO3	is able to present a research problem and its solution on a poster or verbally (EL3_U07);				
LO4	uses different techniques to transfer knowledge and communicate with others (EL3_K05).				
Basic references:	1. Niedzicki W.: Sekrety prezentacji nauki. Ambernet Sp. z o.o., Warszawa, 2004. 2. Niedzicki W.: Sztuka prezentacji w nauce, biznesie i polityce. Poltext Sp. z o.o., 2010. 3. Pietroń K.: Autoprezentacja w zakresie pracy głosem. Wyd. Uniwersytetu Kard. St. Wyszyńskiego w Warszawie, Warszawa, 2014. 4. Stevens M.: Improving your presentation skills: a complete action kit. Kogan, London, 1988. 5. How to make presentations, www.kent.ac.uk/careers/presentationskills.html (20/04/2015), University of Kent.				
	Methods of assessing a learning outcome:				Type of class where the outcomes are assessed
LO1	assessment of students' participation in discussions;				L
LO2	assessment of students' multimedia presentations;				L
LO3	assessment of students' speeches with the use of a poster or multimedia software;				L
LO4	assessment of students' activity during classes.				L
Department:	Department of Theoretical Electrotechnics and Metrology		Tutors:	J. Makal	
Date:	28.01.2015		Coordinator:	**Jarosław Makal, Ph.D.**	

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Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Selected problems of dynamical systems theory**				
Module type:	**optional**	Semester: **3**	ECTS: **2**	Module ID:	**ES3D W33 01**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to acquaint students with selected problems and methods of analysis of continuous-time and discrete-time dynamical systems; to acquaint students with basic methods used in mathematical modelling of dynamical systems; to present examples of applications of the method in Electrotechnics and Automatic Control Systems.				
Assessment:	written test.				
Module content:	Analogies and differences in continuous-time and discrete-time Control Theory Systems. Generalised continuous-time and discrete-time non-linear and linear systems. Weierstrass-Kroneker decomposition of singular linear systems. Reduction of singular systems to equivalent standard systems – the application of a shuffle algorithm. Decomposition of a singular system into dynamic and static parts. Fundamentals of differences calculations theory. Different linear equations. Applications of zet transform to the analysis of linear systems. Time characteristic of linear discrete systems. Frequency characteristic of discrete linear systems. Elementary operations on matrices. Determination of left and right dividers of polynomial matrices. Fractional description of continuous-time and discrete-time linear systems. Singular value decomposition of matrices and its applications.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has good knowledge of mathematical methods in modelling dynamical systems;				
LO2	has advanced knowledge of the methods of description and analysis of dynamical systems;				
LO3	is able to use the knowledge in the research of practical problems and in solving new problems;				
LO4	realises the need of self-instruction and development in the field of modern automatic control.				

Basic references:	1. Kaczorek T.: Theory of control systems. Wydawnictwo Naukowe PWN, Warszawa, 1997 (in Polish). 2. Kaczorek T., Dzieliński A., Dąbrowski W., Łopatka R.: Principles of control theory systems. Wydawnictwo WNT, Warszawa, 2004. 3. Isidori A.: Nonlinear control systems. Springer-Verlang, Berlin, 1995. 4. Kaczorek T.: Polynomial and rational matrices. Springer-Verlang, London, 2007. 5. Kaczorek T.: Selected problems of fractional systems theory. Springer-Verlang, Berlin 2011. 6. Kaczorek T., Sajewski Ł.: The realisation problem for positive and fractional systems. Springer-Verlang, 2014. 7. Kaczorek T., Rogowski K.: Fractional linear systems and electrical circuits. Springer-Verlang, 2014.		
	Methods of assessing a learning outcome:		Type of class where the outcomes are assessed
LO1	examination, written form;		L
LO2	examination, written form;		L
LO3	observation and discussion during lessons;		L
LO4	observation and discussion during lessons.		L
Department:	Department of Automatic Control and Electronics	Tutors:	T. Kaczorek
Date:	30.12.2014	Coordinator:	**prof. Tadeusz Kaczorek**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**Modern electronic materials**				
Module type:	**optional**	Semester: **3**	ECTS: **2**	Module ID:	**ES3D W33 02**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0 S – 0
Prerequisites:	-				
Aims and objectives:	to acquaint students with the classification, properties and application areas of materials in the design of electrical and electronic equipment; to acquaint students with the methods of manufacturing and the evaluation of properties of thin films serving as conductive, insulating, superconducting, reflective, optical and protective materials; to acquaint students with the technology of micromaterials and smart engineering materials; to teach students how to design electrical and electronic materials; to acquaint students with the trends in the development of electrical and electronic materials.				
Assessment:	final written test.				
Module content:	Classification, characteristics and applications of materials (metals, ceramics, glass, composites, carbon materials, polymers, sintered materials) in the design of electrical and electronic systems. Thin films serving as conductive, insulating, superconducting, reflective, optical and protective materials. Micromaterial technology (Si, SOI, SiGe, semiconductors of III-V groups) used in emission and detection systems. Design of electrical and electronic materials and examples of their applications. Smart engineering materials. Prospects for the development of electrical and electronic materials.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	classifies electrical and electronic materials and identifies areas for their applications (EL3_W02);				
LO2	describes the properties and manufacturing technology of materials used in integrated optics (EL3_W02, EL3_U01);				
LO3	discusses manufacturing methods and properties of thin films (EL3_W02, EL3_U01);				
LO4	describes the technology of micromaterials and smart engineering materials (EL3_U01, EL3_U02);				
LO5	discusses the methods of electrical and electronic material design (EL3_U01, EL3_U02);				
LO6	indicates prospects for the development of electrical and electronic materials (EL3_K01, EL3_K05).				
Basic references:	1. Safa O. Kasap, Principles of electronic materials and devices, McGraw-Hill, 2006. 2. M. Jamal Deen, Prasanta Kumar Basu, Silicon Photonics: Fundamentals and Devices, John Wiley & Sons, 2012. 3. Kumar, P. R. Sasi, Photonics, Prentice-Hall of India, 2012. 4. Maurice Quillec, Materials for Optoelectronics, Springer; 1996.				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final written test;	L
LO2	final written test;	L
LO3	final written test;	L
LO4	final written test;	L
LO5	final written test;	L
LO6	final written test.	L

Department:	Department of Electrical Power Engineering, Photonics and Lighting Technology	Tutors:	J. Dorosz
Date:	30.12.2014	Coordinator:	**prof. Jan Dorosz**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Thermography**				
Module type:	**optional**	Semester: **3**	ECTS: **1**	Module ID:	**ES3D W33 03**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	Teaching physical background of thermography, presentation of main issues of thermovision techniques and metrological parameters of thermal imaging cameras and pyrometers. Familiarising with the use of thermography and thermal imaging systems.				
Assessment:	final written test.				
Module content:	Blackbody radiation, spectral and energy properties. Properties of thermal radiators. Blackbody models, emissivity. Infrared radiation detectors – properties, construction, applications. Cooling methods – requirements and technical capabilities. Detectors with cascade structures. Optical materials for infrared range. Methods of detection and visualisation for infrared signals analysis systems. Selected infrared devices, construction, properties and applications. Selected constructions of thermal imaging cameras and their applications.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	knows physical background of thermography (EL3_W01);				
LO2	has orientation in fundamental issues of thermal imaging techniques and pyrometry (EL3_W01, EL3_W02);				
LO3	can choose among selected thermal instruments on the basis of their metrological properties (EL3_U01, EL3_U02);				
LO4	is familiar with the requirements related to the selection of the method and expected effects of the thermal camera applications (EL3_U01).				
Basic references:	1. Madura H. i inni: Pomiary termowizyjne w praktyce. Pomiary Automatyka Kontrola, Warszawa, 2004. 2. Żuber J., Jung A,: Metody termograficzne w diagnostyce medycznej. Państwowe Wydawnictwa Naukowe, Warszawa, 1997. 3. Borkowski S.: Technika podczerwieni i noktowizyjna. Państwowe Wydawnictwa Naukowe, Warszawa, 1989. 4. Więcek B., De Mey G.: Termowizja w podczerwieni – podstawy i zastosowania. Wydawnictwo PAK, Warszawa, 2011. 5. Więcek B.: Wybrane zagadnienia współczesnej termowizji w podczerwieni. Wydawnictwa Politechniki Łódzkiej, Łódź, 2010. 6. Gaussorgues G.: Infrared Thermography. Springer Science & Business Media, 1993. 7. Minkina W., Dudzik S.: Infrared Thermography: Errors and Uncertainties. John Wiley & Sons (e-Book), 2009.				

	Methods of assessing a learning outcome:			Type of class where the outcomes are assessed
LO1	final written test;			L
LO2	final written test;			L
LO3	final written test;			L
LO4	final written test.			L
Department:	Department of Electrical Power Engineering, Photonics and Lighting Technology	Tutors:	A. Zając	
Date:	18.02.2015	Coordinator:	**prof. Andrzej Zając**	

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**Power electronics in integrated photovoltaic power systems**				
Module type:	**optional**	Semester: **3**	ECTS: **1**	Module ID:	**ES3D W33 04**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to acquaint students with the production and storage of ecological energy using power converters; to acquaint students with the methods for optimal control and transfer of ecological energy to the AC grid or to local consumers; to teach the ability to perceive new problems and technical tasks; to teach students how to plan and conduct their own research project in a proper manner; to convince students of the need to systematically and consciously analyse photovoltaic renewable energy technologies.				
Assessment:	final written test (an additional oral assessment possible).				
Module content:	The use of high-power converters, the optimal control and storage of energy from photovoltaic modules and fuel cells, transfer of the energy to the AC grid or to local consumers. Structures of isolated, low-frequency, high frequency, and transformerless boost inverters, transformerless central inverters and their comparison. The structures of photovoltaic modules and their market applications. Examples of photovoltaic power plants. The methods of forming the output waveform. Unipolar, bipolar, hybrid, H5 and HERIC modulation. Review of control structures. Control of conventional structures. Specialised controllers. Control of resonant circuits. Harmonic compensation. Monitoring of the grid. Discrete Fourier analysis. Network synchronisation. The use of phase-locked loop. Linearisation of the PLL small signal model. Dynamic response. Adaptive filtering. Requirements and standards for the cooperation of photovoltaic systems with the industrial grid. Trends and developments in the field of integrated photovoltaic power systems.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has advanced knowledge of a fundamental nature in power electronics, relating to the manufacture, storage, and transmission of energy gained from power photovoltaic systems (EL3_W01, EL3_W02);				
LO2	has good theoretical knowledge concerning the latest systems and technologies and the efficiency of boost converters predisposed for photovoltaic applications (EL3_W02);				
LO3	has the ability to see new problems and technical tasks, to plan and conduct their own research project, and to assess the usefulness and possibility of application of the results of theoretical work in practice (EL3_U02);				
LO4	consciously analyses and evaluates initiatives connected with photovoltaic technologies and renewable energy sources; enhances his/her professional skills (EL3_U01, EL3_K01).				

Basic references:	1. Tunia H., Barlik R.: Teoria przekształtników. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2003. 2. Strzelecki R., Benysek G.: Power electronics in smart electrical energy networks. Springer, Berlin, 2008. 3. A collection of selected articles and papers, prepared the audience in the form of a CD-ROM, including: - Silva S.M., Lopes M., Filho B.J.G., Campana R.P., Bosventura W.E.: Performance evaluation of PLL algorithms for singlephase grid-connected systems. Proc. Industry Applications Conference, 2004. - Rodriguez P., Luna A., Ciobotaru M., Teodorescu R., Blaabjerg F.: Advanced grid synchronisation system for power converters under unbalanced and distorted operating conditions. Proc. IEEE IECON'06, 2006. - Rodriguez P., Luna A., Candela I., Teodorescu R., Blaabjerg F.: Grid synchronisation of power converters using multiple second order generalised integrators. Proc. IEEE IECON'08, 2008. - Blaabjerg F., Iov F., Kerekes T., Teodorescu R.: Trends in power electronics and control of renewable energy systems. Proc. EPE-PEMC, 2010. - Teodorescu R., Rodriguez P., Liserre M.: Power electronics for PV power systems integration. Proc. IEEE Int. Symp. on Industrial Electronics, 2010. - Kawamura A., Pavlovsky M., Tsuruta Y.: State-of-the-art high power density and high efficiency DC-DC chopper circuits for HEV and FCEV applications. 13th Int. Power Electronics and Motion Control Conf., 2008.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written test, oral exam;	L
LO2	written test, oral exam;	L
LO3	written test, oral exam;	L
LO4	written test, oral exam.	L

Department:	Department of Automatic Control and Electronics	Tutors:	J. Dawidziuk
Date:	30.01.2015	Coordinator:	**prof. Jakub Dawidziuk**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**Applied informatics**				
Module type:	**optional**	Semester: **3**	ECTS: **2**	Module ID:	**ES3D W33 05**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0 S – 0
Prerequisites:	-				
Aims and objectives:	to provide some of the principles of numerical algorithms implemented in electrotechnics and electronics; to review concepts of some essential numerical schemes and judgement of their properties, to help students realise that the precision and reliability of calculation results requires the introduction of specific assumptions and constraints, to help students recognise computational contexts in which numerical schemes can be classified and selected.				
Assessment:	assessment of the homework and final written test.				
Module content:	Numerical representation of data. Floating point representation of numbers, constructions and properties of BFP and DFP formats. Accuracy of numerical calculation and basic sources of errors. Numerical approximation of common operators of vector calculus. Order of the numerical approximation and order of the method. Numerical complexity of some algorithms applied in electrical engineering. Stability and convergence of the algorithms. Selected numerical schemes implemented in vector and matrix calculus: iterative methods, preconditioners, multilevel methods. Numerical methods implement in non-linear issues. Numerical integration schemes applied to finite, integral order and fractional order cases. Numerical formulation of optimisation problem. Formulation and implementation of deterministic, heuristic, and biologically oriented algorithms. Construction and implementation of dynamic data structures. Implementation of some specific hardware platforms (distributed and parallel processing). Domain and task decomposition. Paradigms of distributed computations. Limitations and constraints of sequential and distributed algorithms.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has advanced knowledge of basic issues concerning numerical methods applied in the area of her/his research (EL3_W01, EL3_W02);				
LO2	has the knowledge of the methodology of conducting scientific research using computational methods, and of the legal and ethical aspects of scientific work (including the use of special, commercial and open-access software packages) (EL3_W03);				
LO3	can assess the usefulness of some algorithms and the possibility to apply them, and can critically evaluate the results of numerical computations (EL3_U02);				

LO4	can solve complex tasks and problems connected with the scientific discipline they represent (including non-standard tasks), using some numerical methods and available computational packages and other numerical tools (EL3_U04);
LO5	realises and feels the need for further education, for improving their professional and personal competence, and for analysing the latest achievements related to the scientific discipline he/she represents (EL3_K01).

Basic references:

1. Kincaid D., Cheney W.: Numerical analysis. John Wiley & Sons. Polish edition: WNT, Warszawa, 2006.
2. Rosłoniec S.: Fundamental numerical methods for electrical engineering. Springer, Berlin, 2008.
3. Press W.H.: Numerical recipes: the art of scientific computing. Cambridge University Press, Cambridge, 2007.
4. Roosta S.H.: Parallel processing and parallel algorithms - theory and computation. Springer, Berlin, 2000.
5. Dasgupta S., Papadimitriou C., Vazirani U.: Algorytmy. PWN, Warszawa, 2010.
6. Kusiak J.: Optymalizacja: wybrane metody z przykładami zastosowań. PWN, Warszawa, 2009.
7. Fortuna Z., Macukow B., Wasowski J.: Metody numeryczne. WNT, Warszawa, 2009.
8. Stachurski A.: Wprowadzenie do optymalizacji. Oficyna Wyd. Politechniki Warszawskiej, Warszawa, 2009.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	assessment of the homework and final written test;	L
LO2	assessment of the homework and final written test;	L
LO3	assessment of the homework and final written test;	L
LO4	assessment of the homework and final written test;	L
LO5	assessment of the homework and final written test.	L

Department:	Department of Theoretical Electrotechnics and Metrology	Tutors:	B. Butryło
Date:	30.12.2014	Coordinator:	**Bogusław Butryło, D.Sc., Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Mathematical modelling of dynamic systems**				
Module type:	**optional**	Semester: **3**	ECTS: **2**	Module ID:	**ES3D W33 06**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to familiarise students with the methods and techniques of mathematical modelling; to prepare students to create (by themselves) mathematical models of engineering processes which occur in practice.				
Assessment:	Written test to assess the fulfilment of learning outcomes.				
Module content:	Introduction: the scope and goals of mathematical modelling, the definition of a model, stages of mathematical modelling, techniques of model building, computer simulation of mathematical models. Model types: deterministic, probabilistic and stochastic, correlational and casual, static and dynamic, models with parameters concentrated and distributed in space, continuous and discrete, integer and binary models, chaotic models. Principles of mathematical modelling, assumptions, relations between model variables. Analysis of model sensitivity. Model linearisation and linear transformation of state variables. Deterministic models of physical processes. Examples of mathematical modelling in engineering: modelling of vibrations in mechanical systems, mass and heat flow, compartment models. Generalised coordinates, the principle of stationary action (principle of least action). Lagrange and Rayleigh functions. Generalisation of the least action principle. Construction of models of electromechanical systems. Analytical and numerical methods of solving model equations. Approximation models and computer simulation techniques. Selected topics of model parameter identification. Analysis and assessment of differences between a model and a dynamic system. Practical examples of modelling and identification of engineering dynamic systems and technical plants.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has advanced knowledge concerning basic methods of mathematical description of dynamic systems (EL3_W01);				
LO2	has theoretical knowledge gathered from scientific publications concerning mathematical modelling of technical systems in his/her area of research (EL3_W02);				
LO3	can formulate complex problems concerning mathematical modelling of physical phenomena and engineering processes in his/her area of research (EL3_UO3);				
LO4	understands and feels the need for increasing his/her professional competence as well as analysing the latest achievements of mathematical modelling concerning the represented research area (EL3_KO1).				

Basic references:	1. Giordano F. R., Weir M. D., Fox W. P.: A first course in mathematical modelling. Brooks Cole, 2002. 2. Lynch S.: Dynamical systems with applications using Matlab. Birkhäuser, Boston, 2004. 3. Meerschaert M. M.: Mathematical modelling. Academic Press (Elsevier Inc.), 2013. 4. Morrison F.: The art of modeling dynamic systems: forecasting for chaos, randomness and determinism. Dover Books on Computer Science, Dover Publications, 2008. 5. Tung K. K.: Topics in mathematical modelling. Princeton University Press, 2007. 6. Czempik A.: Modele dynamiki układów fizycznych dla inżynierów: zasady i przykłady konstrukcji modeli dynamicznych obiektów automatyki. WNT, Warszawa, 2008. 7. Osowski S.: Modelowanie i symulacja układów i procesów dynamicznych. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2007.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written assessment test;	L
LO2	written assessment test;	L
LO3	written assessment test;	L
LO4	written assessment test;	L

Department:	Department of Automatic Control and Electronics	Tutors:	M. Świercz
Date:	14.01.2015	Coordinator:	**prof. Mirosław Świercz**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Electromagnetic compatibility**				
Module type:	**optional**	Semester: **3**	ECTS: **2**	Module ID:	**ES3D W33 07**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to acquaint students with phenomena related to generation, propagation and influence of electromagnetic disturbances to electric and electronic equipment and systems, as well as couplings between installations; to acquaint students with the techniques of electromagnetic compatibility testing (immunity and emission tests) and basic testing apparatus; to introduce students to the principles of selecting scopes of equipment electromagnetic compatibility tests and ways of their conducting. to acquaint students with the principles of complex testing of electromagnetic compatibility of equipment and systems and the rules of shielding and equipotential bonding in buildings. to acquaint students with threats to people in electromagnetic environment, determination of protective zones, standard recommendations in such situations.				
Assessment:	written test and preparation of a presentation on a selected problem.				
Module content:	Introduction to EMC (ElectroMagnetic Compatibility); EMC standards. Sources of electromagnetic disturbances, their basic characteristics and related threats. Basic principles of disturbing effects of electromagnetic signals, electromagnetic couplings. Tests of immunity of electrical and electronic equipment to electromagnetic disturbances (principles, measurement stations and apparatus, admissible levels). Tests of emissions of electrical and electronic equipment (principles, measurement stations and apparatus, admissible levels). Complex tests of electromagnetic compatibility of equipment and systems. Shielding, equipotential bonding and coordination of cable arrangements in buildings. People in electromagnetic environment. Protection zones, standard recommendations. Practical aspects of electromagnetic compatibility.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	characterises phenomena related to the generation, propagation and influence of electromagnetic disturbances on equipment and systems (EL3_W02);				
LO2	determines basic techniques of electromagnetic compatibility testing and characterises basic requirements concerning testing apparatus (EL3_W02, EL3_W03);				
LO3	selects the scopes of electromagnetic compatibility testing of equipment (EL3_U01, EL3_U02);				
LO4	classifies low voltage installations and determines the possibility of electromagnetic coupling between these installations (EL3_U01, EL3_U02);				
LO5	connects electromagnetic compatibility problems with law regulations and applicable standards (EL3_K01, EL3_K02, EL3_K05).				

Basic references:	1. Ott H. W.: Electromagnetic compatibility engineering. NJ: Wiley, Hoboken, New York, 2009. 2. Kodali V. P.: Engineering electromagnetic compatibility: principles, measurements, technologies and computer models. The Institute of Electrical and Electronics Engineers, New York, 2000. 3. Williams T.: EMC for systems and installations. Newnes, Oxford, 2000. 4. Williams T.: EMC for product designers: (meeting the European EMC directive). Newnes, Oxford, 2000. 5. Więckowski T. W.: Badania kompatybilności elektromagnetycznej urządzeń elektrycznych i elektronicznych. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2001.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written test, presentation of a selected problem;	L
LO2	written test, presentation of a selected problem;	L
LO3	written test, presentation of a selected problem;	L
LO4	written test, presentation of a selected problem;	L
LO5	written test, presentation of a selected problem;	L

Department:	Department of Telecommunications and Electronic Equipment	Tutors:	R. Markowska
Date:	25.11.2014	Coordinator:	**Renata Markowska, D.Sc., Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Optimisation methods**				
Module type:	**optional**	Semester: **3**	ECTS: **2**	Module ID:	**ES3D W33 08**
Number of hours:	L – 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	Introduction to the theoretical issues and algorithms implementation for solving static and dynamic optimisation problems. Presentation of mathematical basis of selected algorithms.				
Assessment:	written test, discussion in class.				
Module content:	Examples and classification of optimisation problems. Introduction to methods for solving static linear and non-linear optimisation problems. The basic properties of the linear programming; simplex method and dual problem. Basics of optimisation methods without constraints. Gradient algorithms for solving optimisation problems without constraints. The impact of constraints on the solution of optimisation problems. Methods and algorithms for solving constrained optimisation. Dynamic optimisation. Maximum principle and dynamic programming.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has advanced theoretical knowledge of solving static linear and non-linear optimisation problems (EL3_W01, EL3_W02);				
LO2	has a good knowledge of selected methods and algorithms for solving constrained optimisation problems using specialised software (EL3_W01, EL3_W02);				
LO3	can make a critical evaluation of the research results (EL3_U02);				
LO4	understands and feels the necessity of lifelong learning, improving professional and personal skills, getting to know the recent developments in a field of scientific discipline (EL3_K01).				
Basic references:	1. Amborski K.: Podstawy metod optymalizacji. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2009. 2. Stachurski A.: Wprowadzenie do optymalizacji. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2009. 3. Kusiak J., Danielewska-Tu|ecka A., Oprocha P.: Optymalizacja. Wybrane metody z przykładami zastosowa˝. PWN, Warszawa, 2009. 4. Stachurski A., Wierzbicki A.: Podstawy optymalizacji. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 1999. 5. Findeisen W., Szymanowski J., Wierzbicki A.: Teoria i metody obliczeniowe optymalizacji. PWN, Warszawa, 1980. 6. Chong E.K.P., »ak S.H.: An introduction to optimisation. J. Wiley, New Jersey, 2008. 7. Bhati A.: Practical Optimisation Methods, Springer, 2000				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written test;	L
LO2	written test;	L
LO3	discussion in class;	L
LO4	discussion in class;	L

Department:	Department of Automatic Control and Electronics	Tutors:	T. Kaczorek
Date:	21.02.2015	Coordinator:	**prof. Tadeusz Kaczorek**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Mathematical statistics**				
Module type:	**optional**	Semester: **3**	ECTS: **1**	Module ID:	**ES3D W33 09**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	Mathematics: calculus, linear algebra, probability theory.				
Aims and objectives:	to introduce students to basic methods of mathematical statistics (one-dimensional random variables and random vectors). to show students how to verify calculations, to draw their attention to the need of drawing conclusions and formulating and justifying opinions. to help students gain the ability to use Excel's statistical functions, tools, and data analysis in Statistica or Matlab.				
Assessment:	Assessment based on 5 reports on selected issues carried out for a specified data set.				
Module content:	Elements of statistical inference of one-dimensional random variable (point estimations, interval estimations, hypothesis testing). Analysis of variance, correlation and regression. Tests for one population and two populations. Matrix approach to linear regression model. Nonlinear regression models.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has advanced knowledge on selected topics of mathematical statistics (EL3_W, 01);				
LO2	is familiar with the possibility of presenting statistical descriptions of research results (EL3_W03);				
LO3	is able to plan statistical research to minimise the number of measurements and verify the results (EL3_U02, EL3_U05);				
LO4	can recognise and formulate complex tasks and problems that may be described in the language of statistics (EL3_U01, EL3_U03).				
Basic references:	1. Richard L. Scheaffer, Madhuri S. Mulekar, James T. McClave, Probability and statistics for engineers, Boston : Brooks/Cole : Cengage Learning, 2011. 2. Wendy L. Martinez, Angel R. Martinez., Computational statistics handbook with MATLAB, Boca Raton : Chapman a. Hall/CRC, 2008. 3. Bilal M. Ayyub, Richard H. McCuen. Probability, statistics and reliability for engineers and scientists, Boca Raton : Chapman a. Hall/CRC, 2003. 4. John O. Rawlings, Sastry G. Pantula, David A. Dickey., Applied regression analysis : a research tool, New York : Springer-Verlag, 1998.				

	Methods of assessing a learning outcome:			Type of class where the outcomes are assessed
LO1	evaluation of reports;			L
LO2	evaluation of reports;			L
LO3	evaluation of reports;			L
LO4	evaluation of reports.			L
Department:	Faculty of Computer Science, Department of Mathematics	Tutors:	D. Mozyrska	
Date:	24.11.2014	Coordinator:	**Dorota Mozyrska, D.Sc., Ph.D.**	

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**English**				
Module type:	**optional**	Semester: **3**	ECTS: **1**	Module ID:	**ES3D W33 10**
Number of hours:	L - 0	E - 15	LC - 0	P - 0	SW - 0 S – 0
Prerequisites:	-				
Aims and objectives:	to develop reading and listening skills in English in order to access and interpret the materials necessary in conducting research and teaching students; to acquire competences necessary to follow discussions with foreign colleagues, describe research and write introductions to scientific papers.				
Assessment:	Graded credit: a term paper (an introduction to a scientific article), a final test.				
Module content:	English for Specific Purposes – basic technical vocabulary and word phrases connected with Electrotechnics. Describing shapes, graphs, diagrams, technical drawings and visual data. Expressing numerical data, numbers and calculations. Grammar issues – passive voice. An overview of writing in the sciences. Writing an introduction to a paper. English-Polish and Polish-English translations of scientific papers.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	knows basic technical vocabulary and word phrases connected with the specialisation (EL3_W02, EL3_W05, EL3_K01);				
LO2	understands scientific papers, writes an introduction to a scientific paper (EL3_U01, EL3_U06, EL3_U07);				
LO3	knows grammar used in scientific papers (EL3_U01, EL3_K01);				
LO4	translates Polish to English and vice versa (EL3_U07, EL3_K02, EL3_K05).				

Basic references:	1. Macpherson R.: English for Academic Purposes. PWN, Warszawa, 2007. 2. McCarthy M.: Academic vocabulary in use. Cambridge University Press, Cambridge, 2008. 3. Bonamy D.: Technical English 3. Longman-Pearson Education, Essex, 2008. 4. Armer T.: Cambridge English for Scientists. Cambridge University Press, Cambridge, 2012. 5. Ibbotson M.: Cambridge English for Engineering. Cambridge University Press, Cambridge, 2008. 6. Hewings M., Thaine C.: Cambridge Academic English. Cambridge University Press, Cambridge, 2008. 7. MacKenzie I.: Professional English in Use: Engineering. Cambridge University Press, Cambridge, 2009. 8. Chadaj S.: Język angielski zawodowy w branży elektronicznej, informatycznej i elektrycznej. WSiP, Warszawa, 2013. 9. Śleszyńska M.: Get Ready for Technical B2. Politechnika Białostocka, Białystok, 2011. 10. http://online.stanford.edu/Writing_in_the_Sciences_Fall_2014 11. www.uefap.com 12. Specialist and technical dictionaries e.g. www.tech-dict.pl, http://pl.glosbe.com http://megaslownik.pl

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	technical and academic vocabulary test;	E
LO2	an introduction to a scientific paper;	E
LO3	a grammar test;	E
LO4	oral and written translations of scientific materials.	E

Department:	Foreign Languages Centre	Tutors:	M. Śleszyńska
Date:	30.12.2014	Coordinator:	**Monika Śleszyńska, M.Sc.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Approximation methods in integral and differential calculus**				
Module type:	**optional**	Semester: **4**	ECTS: **2**	Module ID:	**ES3D W44 01**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	Mathematics.				
Aims and objectives:	to acquaint students with some of the analytical and approximation methods applied for the calculation of ordinary differential equations, partial differential equations and fractional order integro-differential equations; to familiarise students with some specific assumptions and constraints connected with analysed problems.				
Assessment:	assessment of the homework and final written test.				
Module content:	Classification of methods applied in the analysis of issues described by: ordinary differential equations, partial differential equations, fractional order integro-differential equations. Analytical methods: Laplace method, methods of conformal transformations, variational methods, functional analysis. Numerical methods: finite difference method, finite element method. Open boundary issues and the formulation of boundary element method. Approximation schemes implemented in the analysis of fractional order integro-differential cases. Properties of the discussed methods and the demonstration of their implementation. Galerkin's method and its implementation to the analysis of non-linear problems.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has advanced knowledge of some methods applied in the analysis of integral and/or differential equations (EL3_W01, EL3_W02);				
LO2	can identify and formulate complex tasks and problems related to the analysis and synthesis of electric issues described by integral and differential equations (EL3_U03);				
LO3	can choose an effective method to solve a problem described by integral and differential equations (EL3_U04);				
LO4	realises and feels the need for further education, for improving his/her professional and personal competence connected with mathematical methods applied in electrical engineering (EL3_K01).				
Basic references:	1. Lehner G.: Electromagnetic field theory for engineers and physicists. Springer, Berlin, 2010. 2. Kincaid D., Cheney W.: Numerical analysis. John Wiley & Sons. Polish edition: WNT, Warszawa, 2006. 3. Sikora R.: Teoria pola elektromagnetycznego. WNT, Warszawa, 2006. 4. Jabłoński P. Metoda elementów brzegowych w analizie pola elektromagnetycznego. Wydawnictwo Politechniki Częstochowskiej, Częstochowa, 2003. 5. Bolkowski S., Sikora J., Skoczylas J., Sroka J., Stabrowski M., Wincenciak S.: Komputerowe metody analizy pola elektromagnetycznego. WNT, Warszawa, 1993. 6. Kącki E., Małolepszy A., Romanowicz A.: Metody numeryczne dla inżynierów. Wydawnictwo Politechniki Łódzkiej, Łódź, 2000. 7. Landau L.D., Lifsic E.M.: Teoria pola. PWN, Warszawa, 2009.				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	assessment of homework and final written test;	L
LO2	assessment of homework and final written test;	L
LO3	assessment of homework and final written test;	L
LO4	assessment of homework and final written test.	L

Department:	Department of Theoretical Electrotechnics and Metrology	Tutors:	B. Butryło
Date:	30.12.2014	Coordinator:	**Wiesław Peterson, D.Sc., Ph.D.** **Bogusław Butryło, D.Sc., Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**Electronic equipment devices**				
Module type:	**optional**	Semester: **4**	ECTS: **2**	Module ID:	**ES3D W44 02**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	Acquaint students with selected kinds of electronic equipments and modern methods of design them.				
Assessment:	written final test.				
Module content:	Main conception and structures of electronic equipment. Kinds of electronic devices. Power amplifiers - classes and regimes of work, methods of designing. LC and crystal oscillators. Analog modulations: AM, PM, FM, structures of modulators and demodulators. Pulse modulation methods. Automatic gain control and automatic frequency control. PLL in electronic devices. Modern CAD methods of electronic devices. Modelling and optimisation of electronic devices. Perspectives of development CAD methods. Wireless communication systems idea. Radiocommunication channels multiplexing. Examples of radiocommunication systems.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has a detailed and theoretically founded knowledge of the electronic equipment (EL3_W01);;				
LO2	has advanced knowledge about modelling of electronic equipment (EL3_W01, EL3_W02);				
LO3	has knowledge about scientific researches in electronic equipment area (EL3_W03);				
LO4	able to acquire and integrate information from literature and other sources and make the proper selection and interpretation of this information (EL3_U01, EL3_K01).				
Basic references:	1. Alencar M., da Rocha V.C.: Communication systems; Springer 2005. 2. Besser L.., Gilmore R.: Practical RF circuit design for modern wirelesss systems. Vol.1, Vol.2, Artech House 2003. 3. Horowitz P., Hill W., The art of electronics. Cambridge University Press 1998. 4. Gray P.R., Hurst P.J., Lewis S.H., Meyer R.G.: Analysis and Design of Analog Integrated Circuits, Wiley 2009				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written final test;	L
LO2	written final test;	L
LO3	written final test;	L
LO4	written final test.	L

Department:	Department of Telecommunications and Electronic Equipment	Tutors:	G. Czawka
Date:	30.01.2015	Coordinator:	**prof. Giennadij Czawka**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**Methods and algorithms of artificial intelligence**				
Module type:	**optional**	Semester: **4**	ECTS: **2**	Module ID:	**ES3D W44 03**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to familiarise students with theoretical principles of the methods and algorithms of artificial intelligence (AI): artificial neural networks, fuzzy logic and fuzzy systems, evolutionary algorithms and rough sets. to familiarise students with typical applications of AI in engineering problems, e.g.: process modelling and identification, control and diagnostics in technical systems, approximation of multidimensional mapping, pattern classification and recognition, time series prediction.				
Assessment:	Oral or written test.				
Module content:	Basic concepts and terms of computational intelligence, knowledge representation and decision-support systems. Typical applications of Artificial Intelligence. Machine learning and expert systems. Models of an artificial neuron, architectures and training methods of feedforward neural networks. Radial Basis Functions (RBF) neural networks. Self-organising networks: Kohonen maps and LVQ networks. Application of neural networks: approximation of multidimensional mappings, prediction, classification, signal processing, modelling of dynamic systems. Basic concepts and terms of fuzzy systems, fuzzy sets and fuzzy relations. Fuzzy models, fuzzy systems for pattern recognition, modelling, classification and control. Neuro-fuzzy systems: architectures and training. Basic concepts of genetic algorithms: methods of chromosome construction, genetic operators, selection methods, population models. Application of genetic systems. Evolutionary algorithms – principles, tuning, applications. Basic concepts of rough sets: data representation, relations, attributes, methods of attribute reduction. Approximation of rough set family, rough classification algorithms. Methods of rough reasoning. Application of rough sets to pattern and data classification.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has advanced knowledge concerning the basic methods and algorithms of artificial intelligence (EL3_W01);				
LO2	has theoretical knowledge gathered from scientific publications concerning the application of AI to solve engineering problems in his/her area of research (EL3_W02);				
LO3	can formulate complex problems concerning the application of selected AI methods and tools in the area of his/her research (EL3_U03);				
LO4	understands and feels the need for increasing his/her professional competence, as well as analysing the latest achievements of artificial intelligence concerning the represented research area (EL3_K01).				

Basic references:	1. Berkan R. C.: Fuzzy systems design principles: building fuzzy if-then rule bases. The Institute of Electrical and Electronics Engineers, New York, 1997. 2. Cherkassky V.: Learning from data: concepts, theory, and methods. John Wiley and Sons, Hoboken, 2007. 3. Haykin S.: Neural networks: a comprehensive foundation. Prentice-Hall, Upper Saddle River, 1999. 4. Jensen R,: Computational intelligence and feature selection: rough and fuzzy approaches. John Wiley and Sons, Hoboken, 2008. 5. Norgaard M., et al.: Neural networks for modelling and control of dynamic systems: a practitioner's handbook. Springer-Verlag, London, 2000. 6. Poli R., et al.: A field guide to genetic programming. Lulu Enterprises, 2008. 7. Rutkowski L.: Metody i techniki sztucznej inteligencji: inteligencja obliczeniowa. PWN, Warszawa, 2009.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	oral or written exam;	L
LO2	oral or written exam;	L
LO3	oral or written exam;	L
LO4	oral or written exam.	L

Department:	Department of Automatic Control and Electronics	Tutors:	M. Świercz
Date:	14.01.2015	Coordinator:	**prof. Mirosław Świercz**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Dynamical systems with uncertain parameters**				
Module type:	**optional**	Semester: **4**	ECTS: **2**	Module ID:	**ES3D W44 04**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to introduce students to the basic methods of analysis of dynamical systems with uncertain parameters whose values are known with an accuracy of numerical intervals. to familiarise students with example issues of control theory and the theory of electrical circuits for the systems with uncertain parameters.				
Assessment:	written test, discussion in class.				
Module content:	Description of dynamical systems with uncertain parameters. Introduction to the theory of interval analysis, arithmetic operations on interval real and complex numbers. Robust stability analysis of families of characteristic polynomials with coefficients linearly and multilinearly dependent on uncertain parameters. Kharitonov's theorem and the edge theorem. Frequency analysis of linear electrical circuits with uncertain parameters. Computer methods for determining envelopes of interval transfer functions families. Frequency characteristic envelopes of a family of second order passive filters.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has advanced theoretical knowledge of selected methods of analysis of dynamical systems with uncertain parameters (EL3_W01);				
LO2	has a good knowledge of selected methods of frequency analysis of second order passive filters with uncertain parameters (EL3_W02);				
LO3	can make a critical evaluation of research results (EL3_U02);				
LO4	understands and feels the necessity of lifelong learning, improving professional and personal skills, getting to know recent developments in the field of his/her scientific discipline (EL3_K01).				
Basic references:	1. Białas S.: Odporna stabilność wielomianów i macierzy. Wydawnictwa Uczelniane AGH, Kraków, 2002. 2. Busłowicz M.: Stabilność układów liniowych stacjonarnych o niepewnych parametrach. Wydawnictwa PB, Białystok, 1997. 3. Busłowicz M.: Frequency responses of second order RLC series circuits with uncertain parameters. Computer Applications in Electrical Engineering (red. R. Nawrowski), Wydawnictwa Politechniki Poznańskiej, Poznań, 2004. 4. Galias Z.: Metody arytmetyki przedziałowej w badaniach układów nieliniowych. Wydawnictwa Uczelniane AGH, Kraków, 2003. 5. Oprzędkiewicz K.: Praktyczne sterowanie systemami dynamicznymi z widmem punktowym i parametrami rozłożonymi. Wydawnictwa Uczelniane AGH, Kraków, 2008. 6. Dubravska M., Harsanyi L.: Control of uncertain systems. Journal of Electrical Engineering, vol. 58, no. 4, pp. 228–231, 2007. 7. Bhattacharyya S. P., Chapellat H., Keel L. H.: Robust control: the parametric approach. Prentice Hall PTR, New York, 1995.				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written test;	L
LO2	written test;	L
LO3	discussion in class;	L
LO4	discussion in class.	L

Department:	Department of Automatic Control and Electronics	Tutors:	A. Ruszewski
Date:	18.12.2014	Coordinator:	**Andrzej Ruszewski, Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Theory of fractional systems**				
Module type:	**optional**	Semester: **4**	ECTS: **1**	Module ID:	**ES3D W44 05**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to acquaint students with selected problems and methods of analysis of continuous-time and discrete-time fractional systems; to acquaint them with the mathematical modelling of fractional linear and non-linear systems; to acquaint students with the application of the methods for fractional linear and non-linear systems in electrical engineering and automatic control systems. The methods will be applied to linear and non-linear electrical circuits. They will be also extended to descriptor fractional linear and non-linear systems.				
Assessment:	final written test.				
Module content:	Analogy and differences in continuous and discrete-time analysis of standard and fractional systems. Generalised dynamical fractional continuous-time and discrete-time linear systems. Definitions of Euler gamma function and Mittag-Leffler function and their properties. Definition of fractional order differential-integral. Solution of state space equations of continuous-time fractional linear system. Definition of n-order backward difference of discrete-time system. State space equations of discrete-time linear systems and their solution. Stability and stabilisation of linear fractional-order systems. Practical stability of fractional-order linear systems. Practical stabilisation of discrete time systems with the use of state feedback. Positive fractional order continuous-time and discrete-time systems. Descriptor positive fractional systems.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has a good basic knowledge of fractional order difference and differential (EL3_W01, EL3_W02);				
LO2	is well able to describe and analyse fractional order dynamical systems (EL3_W02);				
LO3	is able to use the acquired knowledge to research and solve practical problems (EL3_U02);				
LO4	has a need to self-educate and develop in the field of modern automatic control and to apply the theory to solve practical problems (EL3_K01).				
Basic references:	1. Kaczorek T.: Wybrane zagadnienia teorii układów niecałkowitego rzędu. Oficyna Wydawnicza Politechniki Białostockiej, Białystok, 2009. 2. Ostalczyk P.: Zarys rachunku różniczkowo – całkowego ułamkowego rzędu. Oficyna Wydawnicza Politechniki Łódzkiej, Łódź, 2009. 3. Kaczorek T.: Selected problems of fractional systems theory. Springer, Berlin, 2011. 4. Podlubny I.: Fractional differential equations. Academic Press, London, 1999.				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final written test;	L
LO2	final written test;	L
LO3	observation and discussion during lectures;	L
LO4	observation and discussion during lectures.	L

Department:	Department of Automatic Control and Electronics	Tutors:	T. Kaczorek
Date:	30.01.2015	Coordinator:	**prof. Tadeusz Kaczorek**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Modern metrology**				
Module type:	**optional**	Semester: **4**	ECTS: **1**	Module ID:	**ES3D W44 06**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to bring to student's attention the significance and role of uncertainty estimation in conducting research; to familiarise them with the trends for the application and development of metrology; to introduce them to the scope and matter of legal metrology.				
Assessment:	written test.				
Module content:	The accuracy of measuring systems. The use of specification data of instruments. Planning and analysis of an experiment. New trends in measurement instrumentation development. Virtual instruments – advantages and disadvantages. Remote measurements, e.g. with the use of the Internet. The legal aspects of measurements. Standardisation and calibration. Certificates and the procedure of notification.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	can estimate the effectiveness of applied measuring methods (EL3_U01);				
LO2	describes the basic elements of the legal metrology and their significance in research (EL3_W01);				
LO3	is able to discuss metrology-related problems in his/her field of research (EL3_W01);				
LO4	names and describes modern trends in metrology (EL3_W02, EL3_K01).				
Basic references:	1. Praca zbiorowa: Transverse disciplines in metrology. French College of Metrology, Wiley, dostępne na stronach http://onlinelibrary.wiley.com. 2. Wheeler A. J., Ganji A.R.: Introduction to engineering experimentation. Prentice Hall, London, 2006. 3. Materiały sekcji TC4 IMEKO Novelties in Electrical Measurements and Instrumentations. 4. Wybrane artykuły publikowane w czasopiśmie Pomiary Automatyka Kontrola. 5. Wybrane polskie normy: PN-EN ISO 9001:2001, PN-EN ISO 14001:1998, PN-N-18001:2004. 6. Guide to the expression of uncertainty in measurement. Wersja poprawiona, 1995, dostępne na stronach www.bipm.org. 7. Biuletyn Głównego Urzędu Miar.				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written test;	L
LO2	written test;	L
LO3	assessment of students' participation in the classes;	L
LO4	written test.	L

Department:	Department of Theoretical Electrotechnics and Metrology	Tutors:	**J. Makal, W. Walendziuk**
Date:	28.01.2015	Coordinator:	**Jarosław Makal, Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Analysis and synthesis of non-linear systems**				
Module type:	**optional**	Semester: **4**	ECTS: **1**	Module ID:	**ES3D W44 07**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to acquaint students with selected methods of analysis of geometrical approach to some problems of non-linear systems.				
Assessment:	final written test.				
Module content:	Linear spaces. Operators in linear spaces. Lie-derivative of scalar functions. Lie-bracket of vector fields. Involutive and invariant distribution. Linearisation of full-order non-linear systems. Diffeomorphism and controllability matrix of non-linear systems. Observability matrix of non-linear systems. Reduction of non-linear systems to canonical forms. Linearisation of non-linear systems through changing the basis and non-linear feedbacks. Synthesis of non-linear systems by means of non-linear feedbacks. Decoupling of non-linear systems.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has a basic knowledge of fractional order difference and differential (EL3_W01, EL3_W02);				
LO2	has an advanced knowledge in the methods of description and analysis of fractional order dynamical systems (EL3_W02, EL3_W03);				
LO3	is able to use the knowledge in the research of practical problems and to solve new problems (EL3_U02);				
LO4	has a need to self-educate and develop in the field of modern automatic control and to apply the theory to solve practical problems (EL3_K01).				
Basic references:	1. Jordan A., Kaczorek T., Myszkowski P.: Linearyzacja nieliniowych równań różniczkowych. Wydawnictwo Politechniki Białostockiej, Białystok, 2007. 2. Isidori A.: Nonlinear control systems. Springer, Berlin, 1995. 3. Marino R., Tomei P.: Nonlinear control design. Prentice Hall, London, 1995. 4. Conte G., Moog C.H., Perdon A. M.: Algebraic methods for non-linear control systems. Springer, London, 2010.				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final written test;	L
LO2	final written test;	L
LO3	observation and discussion during lectures;	L
LO4	observation and discussion during lectures.	L

Department:	Department of Automatic Control and Electronics	Tutors:	T. Kaczorek
Date:	30.01.2015	Coordinator:	**prof. Tadeusz Kaczorek**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Selected aspects of electric shock protection**				
Module type:	**optional**	Semester: **4**	ECTS: **1**	Module ID:	**ES3D W44 08**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to acquaint students with the phenomenon of electric shock and the threat associated with the use of electrical equipment; to help students acquire skills necessary to protect oneself against electric-shock and to organise work with high voltage systems in a safe way				
Assessment:	final written test.				
Module content:	Electric-shock risk. Man and the circuit of electric current. Effects of electric current flow through a living organism. Permissible touch current for people and dimensioning the criteria for protection measures against electric shock. Objectives of protection against electric shock. Measures of protection under normal and fault conditions (indirect contact protection) in low voltage installations. Electric shock protection in installations exceeding 1 kV. Standardisation processes and instruments for the protection against electric shock.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has an advanced knowledge of measures for the protection against electric shock (EL3_W01);				
LO2	has a detailed knowledge, obtained in particular from scientific publications, of the effects of touch current shock and the ways of protection against such shocks, which are a source of particular (EL3_W02);				
LO3	is able to effectively obtain, select, and interpret information related to the organisation of safe and efficient work with the use of electrical equipment and protection against electric shock, from a variety of sources, including in foreign languages (EL3_U01);				
LO4	understands the objectives of electric shock protection and feels the necessity of lifelong learning, improving professional competence, analysing the latest developments related to the safety and reliability of electrical installations and power networks (EL3_K01);				
LO5	is able to recognise and formulate complex tasks and problems associated with the safety of installations and power networks (EL3_U03, EL3_K02).				

Basic references:	1. Lejdy B.: Instalacje elektryczne w obiektach budowlanych. WNT, Warszawa, 2013. 2. Markiewicz H.: Instalacje elektryczne. WNT, Warszawa, 2008. 3. PN – HD 60364 Instalacje elektryczne niskiego napięcia – norma wieloarkuszowa. 4. PN – E – 05115:2002 Instalacje elektroenergetyczne prądu przemiennego o napięciu wyższym od 1 kV. 5. PN-EN 50522:2011E Uziemienie instalacji elektroenergetycznych prądu przemiennego o napięciu wyższym od 1 kV. 6. PN-EN 61936-1:2011E Instalacje elektroenergetyczne prądu przemiennego o napięciu wyższym od 1 kV -- Część 1: Postanowienia ogólne. 7. Seip G. G.: Electrical installations handbook. John Wiley & Sons, New York, 2000. 8. PN – EN 61140:2005 P Ochrona przed porażeniem prądem elektrycznym. Wspólne aspekty instalacji i urządzeń. 9. Hofheinz W.: Fault current monitoring in electrical installations : foundations, applications and methods of measuring residual current in AC and DC systems - with residual current monitors (RCMs) according to IEC 62020 an other international standards. VDE-Verlag, 2004. 10. Morrison R.: Grounding and shielding in facilities. John Wiley & Sons, New York, 1990.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final test;	L
LO2	final test, discussion;	L
LO3	final test, discussion during the lecture;	L
LO4	discussion during the lecture;	L
LO5	discussion during the lecture.	L

Department:	Department of Electrical Power Engineering, Photonics and Lighting Technology	Tutors:	M. A. Sulkowski
Date:	30.01.2015	Coordinator:	**Marcin A. Sulkowski, Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**Fractional electrical circuits**				
Module type:	**optional**	Semester: **4**	ECTS: **1**	Module ID:	**ES3D W44 09**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	Introduction to problems and methods of analysis of linear and some classes of non-linear electrical circuits described by differential equations of fractional order.				
Assessment:	final test.				
Module content:	Introduction to fractional order differential equations. Methods of description of fractional continuous-time systems. Introduction to modelling. Modelling of basic elements of electrical circuits by the use of fractional equations. Memristor of standard and fractional order. Example of the circuits with memristors. Extension of classical first order filters on fractional order and its analysis in time and frequency domain. Chaotic systems of standard and fractional order.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has good basis on their knowledge of fractional order differential and its application (EL3_W01, EL3_W02);				
LO2	has advance knowledge in the method of analysis of simple fractional order filters and standard and fractional order chaotic systems (EL3_W02);				
LO3	is able to use the knowledge in research of practical problems and in solving new problems (EL3_U02);				
LO4	has a need to self-instruction and development his knowledge in modern automatic control problems and in application of theory in solving practical problems (EL3_K01).				
Basic references:	1. Jordan A., Kaczorek T., Myszkowski P.: Linearyzacja nieliniowych równań różniczkowych. Wydawnictwo Politechniki Białostockiej, Białystok, 2007. 2. Isidori A.: Nonlinear control systems. Springer, Berlin, 1995. 3. Marino R., Tomei P.: Nonlinear control design. Prentice Hall, London, 1995. 4. Conte G., Moog C.H., Perdon A. M.: Algebraic methods for non-linear control systems. Springer, London, 2010. 5. Kaczorek T.: Wybrane zagadnienia teorii układów niecałkowitego rzędu. Oficyna Wydawnicza Politechniki Białostockiej, Białystok, 2009. 6. Ostalczyk P.: Zarys rachunku różniczkowo – całkowego ułamkowego rzędu. Oficyna Wydawnicza Politechniki Łódzkiej, Łódź, 2009. 7. Kaczorek T.: Selected problems of fractional systems theory. Springer, Berlin, 2011.				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final test;	L
LO2	final test;	L
LO3	observation and discussion during lessons;	L
LO4	observation and discussion during lessons.	L

Department:	Department of Automatic Control and Electronics	Tutors:	T. Kaczorek
Date:	21.02.2015	Coordinator:	**prof. Tadeusz Kaczorek**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**English**				
Module type:	**optional**	Semester: **4**	ECTS: **1**	Module ID:	**ES3D W44 10**
Number of hours:	L - 0	E - 15	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to develop student's reading and listening skills in English in order to access and interpret the materials necessary in conducting research and teaching students. to help students acquire competences necessary to follow discussions with foreign colleagues, describe research ad write summaries to scientific papers.				
Assessment:	a term paper (a summary of a scientific article), a final test.				
Module content:	English for Specific Purposes – extended technical vocabulary and word phrases connected with Electrotechnics. An overview of writing in the sciences. Writing a summary of a scientific article (e.g. a MSc thesis). Language functions at a meeting/conference: expressing opinions, agreeing, disagreeing, making suggestions, socialising. Suffixes and prefixes in technical English, compound nouns. Grammar issues - strong verbs and active voice. Technical English vocabulary of Greek and Latin origin. English-Polish and Polish-English translations of scientific papers.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	knows extended technical vocabulary and word phrases connected with the specialisation (EL3_W02, EL3_W05, EL3_K01);				
LO2	understands scientific papers, writes a summary of a scientific paper (EL3_U01, EL3_U06, EL3_U07);				
LO3	knows grammar used in scientific papers (EL3_U01, EL3_K01);				
LO4	translates Polish to English and vice versa (EL3_U07, EL3_K02, EL3_K05).				

Basic references:	1. Macpherson R.: English for Academic Purposes. PWN, Warszawa, 2007. 2. McCarthy M.: Academic vocabulary in use. Cambridge University Press, Cambridge, 2008. 3. Bonamy D.: Technical English 3. Longman-Pearson Education, Essex, 2008. 4. Armer T.: Cambridge English for Scientists. Cambridge University Press, Cambridge, 2012. 5. Ibbotson M.: Cambridge English for Engineering. Cambridge University Press, Cambridge, 2008. 6. Hewings M., Thaine C.: Cambridge Academic English. Cambridge University Press, Cambridge, 2008. 7. MacKenzie I.: Professional English in Use: Engineering. Cambridge University Press, Cambridge, 2009. 8. Chadaj S.: Język angielski zawodowy w branży elektronicznej, informatycznej i elektrycznej. WSiP, Warszawa, 2013. 9. Śleszyńska M.: Get Ready for Technical B2. Politechnika Białostocka, Białystok, 2011. 10. http://online.stanford.edu/Writing_in_the_Sciences_Fall_2014 11. www.uefap.com 12. Specialist and technical dictionaries e.g. www.tech-dict.pl, http://pl.glosbe.com http://megaslownik.pl

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	a technical and academic vocabulary test;	E
LO2	a summary of a scientific paper;	E
LO3	a grammar test;	E
LO4	oral and written translations of scientific materials.	E

Department:	Foreign Languages Centre	Tutors:	M. Śleszyńska
Date:	30.12.2014	Coordinator:	**Monika Śleszyńska, M.Sc.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Unconventional energy sources**				
Module type:	**optional**	Semester: **5**	ECTS: **2**	Module ID:	**ES3D W55 01**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to learn the construction, operation, and measurement methods of photovoltaic cells parameters; to describe the characteristics of photovoltaic, wind, tidal flows and water; to present of systems using heat pumps and geothermal sources; to present of fuel cells and energy storage energy potential; to present of nuclear energy possibility.				
Assessment:	final written test.				
Module content:	Methods and technologies using solar energy. Photovoltaic effect. Photovoltaic cells and their use. Photovoltaic power plants, wind, tidal, water - classic and peak. The use of biomass for energy. Hybrid power plants. Heat pumps. Geothermal sources and their use. Fuel cells. Energy accumulators. Nuclear power. Prospects for the development of energy generation using renewable sources.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	describes construction, operation and measurement methods of photovoltaic cells parameters (EL3_W01, EL3_W02);				
LO2	defines properties of PV plants, wind plants, tidal and water plants (EL3_W02, EL3_U01);				
LO3	describes systems using heat pumps and geothermal sources, demonstrates and evaluates their applicability (EL3_W02, EL3_U03);				
LO4	describes and explains principle of operation of fuel cells and energy storage, and indicates the possibility of its use in energetics (EL3_W01, EL3_W02, EL3_U02, EL3_U03);				
LO5	discusses risks and benefits of nuclear power (EL3_U01, EL3_K01, EL3_K02, EL3_K05);				
LO6	shows development perspectives of energy generation using renewable sources (EL3_U01, EL3_K01).				

Basic references:	1. Lewandowski W. M.: Proekologiczne odnawialne źródła energii, Warszawa, WNT, 2013. 2. Klugmann-Radziemska E.: Fotowoltaika w teorii i praktyce, Legionowo, BTC, 2010. 3. Tytko R.: Odnawialne źródła energii: wybrane zagadnienia. OWG, Warszawa, 2009. 4. Kubowski J.: Nowoczesne elektrownie jądrowe: fizyka, budowa, technologia, bezpieczeństwo, ekologia, koszty. Wydawnictwo Naukowo - Techniczne, Warszawa, 2010. 5. Luo, Fang Lin.: Renewable energy systems : advanced conversion technologies and applications, Boca Raton : CRC/Taylor & Francis, 2013. 6. Da Rosa, Aldo Vieira: Fundamentals of renewable energy processes, Amsterdam ; Boston : EElsevier/Academic Press, 2009.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final written test;	L
LO2	final written test;	L
LO3	final written test;	L
LO4	final written test;	L
LO5	final written test;	L
LO6	final written test.	L

Department:	Department of Electrical Power Engineering, Photonics and Lighting Technology	Tutors:	M. Zajkowski
Date:	21.02.2015	Coordinator:	**prof. Andrzej Zając**

Faculty of Electrical Engineering						
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**	
Module name:	**Advanced methods of analysis and synthesis of drive systems**					
Module type:	**optional**	Semester: **5**		ECTS: **2**	Module ID:	**ES3D W55 02**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-					
Aims and objectives:	to acquaint students with modern knowledge of selected problems of analysis and synthesis of drive systems; to help students acquire the skills of: carrying out comparative sensitivity and robust analysis of different drive systems, formulating the laws of adaptive control, using identification methods to control drive systems; to enable students to acquire the skills of independent thinking and creative action when searching for new ideas and technical solutions;					
Assessment:	final written test.					
Module content:	Introduction to the analysis and synthesis of the DC and AC drive systems. Synthesis of drive systems using cascade-state method. Direct Lyapunov method and hiperstability as the leading methods of analysis and synthesis of drive systems. Methods of selecting and evaluating the quality of the selection of quadratic forms as candidates for Lyapunov function. The use of the direct Lyapunov method for the analysis of resistance drives systems on fast and slow parameter changes. Application of the direct Lyapunov method for the formulation of adaptive control methods, identification and decoupling of drive systems. The use of time-scale separation method for the simplified analysis and synthesis of drive systems and formulation of the laws of adaptation.					
Learning outcomes:	The student who has passed the module assessment:					
LO1	has a well-grounded, theoretically-based knowledge related to the methods of analysis and synthesis of non-linear dynamical systems (EL3_W02, EL3_U01);					
LO2	can solve complex tasks and problems connected with the analysis of sensitivity and robustness of drive systems (EL3_U02, EL3_U04);					
LO3	can solve complex tasks and problems connected with the adaptive control and parameter identification in drive systems (EL3_U03);					
LO4	has the ability to think creatively, and solve scientific and technical problems independently (EL3_U03, EL3_U04, EL3_K01).					

Basic references:	1. Alahakoon S.: Digital control techniques for sensorless electrical drives. Dr Mueller Verlag, Saarbruecken, 2009. 2. Orłowska-Kowalska T.: Bezczujnikowe układy napędowe z silnikami indukcyjnymi. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2003. 3. Krzemiński Z.: Cyfrowe sterowanie maszynami asynchronicznymi. Wydawnictwo Politechniki Gdańskiej, Gdańsk, 2001. 4. Vukosavic S. N.: Digital control of electrical drives. Springer, New York, 2007. 5. Kaźmierkowski M. P., Krishnan R., Blaabjerg F.: Control in power electronics, selected problems. Academic Press, Amsterdam , 2002. 6. Veltman A., Pule D. W. J., De Doncer R. W.: Fundamentals of electrical drives. Springer, Berlin, 2007.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final written test;	L
LO2	final written test;	L
LO3	final written test;	L
LO4	final written test.	L

Department:	Department of Power Electronics and Electric Drives	Tutors:	M. Dubowski
Date:	12.01.2015	Coordinator:	**prof. Marian Roch Dubowski**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**Application software for the analysis and design of drive systems and inverters**				
Module type:	**optional**	Semester: **5**	ECTS: **2**	Module ID:	**ES3D W55 03**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to acquaint students with selected applications used for the design and analysis of power electronics systems, and electronic and electric drives.				
Assessment:	Submission of a project, evaluation of in-class work with software.				
Module content:	Use of programs for projects and technical documentation regarding power installation and industrial automation. Aided design using selected CAE applications, including the analysis of design activities (simulation), power electronics systems, power electronics modelling of selected issues. Use of Matlab-Simulink together with examples of the use of additional libraries (toolbox). The overview of selected elements from the SimPowerSystems library such as: models of electric machines (DC and AC), transformers, RLC elements, wired lines, generators, signal modulators, controlled and uncontrolled rectifiers, measuring circuits of current, voltage and power. The design of functional blocks in Matlab-Simulink to implement the advanced control algorithms and data processing using the C/C++ programming language.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has a good theoretical knowledge of computer aided analysis and design of power electronics converter and drive systems (EL3_W02);				
LO2	has the ability to solve complex tasks and problems associated with his/her scientific discipline (EL3_U03, EL3_U04);				
LO3	is able to create reports of research and documentation including test results, (EL3_U06);				
LO4	understands and feels the necessity of lifelong learning (EL3_K01).				
Basic references:	1. Mrozek B., Mrozek Z.: Matlab i Simulink - poradnik użytkownika. Helion, Gliwice, 2004. 2. Brzóska J.: Ćwiczenia z automatyki w Matlabie i Simulinku. Mikom, Warszawa, 1997. 3. Łysakowska B., Mzyk G.: Komputerowa symulacja układów automatycznej regulacji w środowisku MATLAB/Simulink. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2005. 4. Messner W.C., Tilbury D.M.: Control tutorials for Matlab and Simulink: user's guide. Addison-Wesley, Menlo Park, 1999. 5. Bismor D.: Programowanie systemów sterowania - narzędzia i metody. WNT, Warszawa, 2010. 6. Mohan N.: Advanced electric drives: analysis, control, and modeling using Matlab/Simulink. J. Wiley and Sons, Hoboken, 2014. 7. Alkin O.: Signals and systems: a Matlab integrated approach. CRC/Taylor & Francis, Boca Raton, 2014.				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	evaluation of in-class work and the project;	L
LO2	evaluation of in-class work and the project;	L
LO3	evaluation of in-class work and the project;	L
LO4	evaluation of in-class work and the project;	L

Department:	Department of Power Electronics and Electric Drives	Tutors:	M. Korzeniewski
Date:	07.12.2014	Coordinator:	**prof. Andrzej Sikorski, Marek Korzeniewski, Ph.D.**

Faculty of Electrical Engineering						
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**	
Module name:	**Electric power networks**					
Module type:	**optional**	Semester: **5**		ECTS: **2**	Module ID:	**ES3D W55 04**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-					
Aims and objectives:	to familiarise students with classical and modern design solutions and phenomena occurring in electric power networks.					
Assessment:	written exam;					
Module content:	Purpose and trends of development of transmission and distribution electric power networks. Modern power lines and substations. Analysis of phenomena occurring in power networks in normal and fault conditions. Causes and effects of disturbance in electric power networks and methods of its elimination. The effect of deformation currents and voltages on the work of elements of power systems. Analysis of cooperation of networks with distributed power sources. Energy efficiency of particular elements of power networks. Power and energy losses in electric power networks. Electric shock protection in medium and high voltage electrical networks.					
Learning outcomes:	The student who has passed the module assessment:					
LO1	identifies and describes modern technologies used in transmission and distribution power networks (EL3_W02);					
LO2	defines and describes basic phenomena concerning electricity networks (EL3_W01, EL3_W02, EL3_U03);					
LO3	describes disturbances occurring in electricity grids and is familiar with the methods of eliminating their negative effects (EL3_U03, EL3_U04).					
Basic references:	1. Grigsby L.: Electric power generation, transmission, and distribution. CRC / Taylor & Francis, Boca Raton, 2012. 2. Gönen T.: Electric power distribution system engineering. CRC / Taylor & Francis, Boca Raton, 2008. 3. Crappe M.: Electric power systems. Wiley, London, 2008. 4. Kothari D.P., Nagrath I.J.: Modern power system analysis. McGraw-Hill, Boston, 2003. 5. Niebrzydowski J.: Sieci elektroenergetyczne. Politechnika Białostocka, 2000.					
	Methods of assessing a learning outcome:					Type of class where the outcomes are assessed
LO1	written exam;					L
LO2	written exam;					L
LO3	written exam.					L

Department:	Department of Electrical Power Engineering, Photonics and Lighting Technology	Tutors:	G. Hołdyński, M. A. Sulkowski
Date:	12.12.2014	Coordinator:	**Grzegorz Hołdyński, Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**Intelligent lighting**				
Module type:	**optional**	Semester: **5**	ECTS: **1**	Module ID:	**ES3D W55 05**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to familiarise students with the physiology of vision, . to familiarise them with the physics of light emitted by modern light sources and the electrical, photometrical and colorimetrical parameters of light sources; to acquaint them with the rules for the measurement of optical radiation of light sources and luminaires in laboratory and real environments; to present trends in modern lighting technology.				
Assessment:	written test;				
Module content:	1. Vision and eye adaptation. 2. Modern light sources – construction and operation parameters. 3. Photometric, colorimetric and electrical characterisation of light sources. 4. Advantages and disadvantages of electroluminescent light sources compared to classical light sources. 5. Measurement of optical radiation. 6. Fixtures, fittings and lighting systems. 7. Interior and exterior intelligent lighting.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	can analyse the degree of adaptation of the eye to the light conditions (EL3_W01, EL3_W02);				
LO2	lists and describes the principle of operation of modern light sources (EL3_W02, EL3_U01, EL3_U02, EL3_K01);				
LO3	can classify luminaires and lighting systems (EL3_U02);				
LO4	can classify optical measurement devices (EL3_U02);				
LO5	can describe the trends of development and the possibilities of application of lighting technology (EL3_U03, EL3_K01, EL3_K03).				

Basic references:	1. Praca zbiorowa: Technika świetlna '2009. Poradnik - informator. Polski Komitet Oświetleniowy, Warszawa, 2013. 2. Brandi U.: Lighting design: principles, implementation, case studies. Birkhäuser, Basel, 2006. 3. Koshel R. J.: Illumination engineering: design with nonimagong optics. John Wiley and Sons, IEEE Press, 2013. 4. Russell S.: The architecture of light: a texbook of procedures and practises for the architect, interior designer, and lighting designer. Conceptnine, 2012. 5. Palmer J. M.: The art of radiometry. SPIE Press, monograph vol. PM184, 2009. 6. Whitehead R.: Residential lightning: a pratical guide to beautiful and sustainable design. John Wiley and Sons, 2008. 7. Sansoni P., Mercatelli L., Farini A.: Sustainable indoor lightinig. Springer, 2015. 8. Kitsinelis S.: Light sources: technologies and applications. CRC Press, 2010. 9. Polskie normy: PN-EN 15193:2010, PN-EN 13201:2012, PN-EN 13032:2010. 10. Schubert E. F.: Light-emitting diodes. Cambridge University Press, 2006.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written test;	L
LO2	written test;	L
LO3	written test;	L
LO4	written test;	L
LO5	written test.	L

Department:	Department of Electrical Power Engineering, Photonics and Lighting Technology	Tutors:	I. Fryc
Date:	30.12.2014	Coordinator:	**Irena Fryc, D.Sc., Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Transmission of electromagnetic waves**				
Module type:	**optional**	Semester: **5**	ECTS: **2**	Module ID:	**ES3D W55 06**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to acquaint students with the issues of electromagnetic wave transmission in wave guides, and in free space in a high frequency range. to enable students to acquire knowledge and skills in the analysis and suitable selection of the means of transmission of waves. to help students make correct use of relations resulting from mathematical models.				
Assessment:	homework and a discussion.				
Module content:	Fundamental equations of electrodynamics. Media types. Wave equations. Properties of a plane wave in a low-loss and lossless dielectric, the loss angle. Discussion of the causes of wave energy losses. Polarisation of plane wave. The applicability of the concepts of current, voltage, and impedance. Electromagnetic field in real conductors, the skin effect. Electromagnetic waves in the TEM and quasi-TEM lines. Structure and characteristics of selected plane wave guides. Propagation of electromagnetic waves in waveguides using a parallel-plate waveguide as an example. Wave types and modes. Features of waves inside waveguides. Transmission and reception of electromagnetic waves. Electromagnetic field distribution in the vicinity of the Hertz dipole. Radiation zones. Parameters of antennas. The radiation field of a thin-wire antenna. The impact of the Earth's surface. Selected antenna structures. Presentation of sample results of analysis of wave radiation, propagation and scattering issues, using numerical methods (the finite element method, the method of moments).				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has an advanced knowledge of the fundamentals of the mathematical description of electromagnetic fields (EL3_W01);				
LO2	has a good theoretical knowledge of details related to waveguide and antenna technology (EL3_W02);				
LO3	can effectively gain information associated with the transmission of electromagnetic waves from various sources, including publications in foreign languages, and make a proper selection and interpretation of this information (EL3_U01);				
LO4	can recognise and formulate complex tasks and problems related to the transmission of electromagnetic waves (EL3_U03);				
LO5	understands and feels the necessity of lifelong learning, improving professional and personal skills, and analysing the latest developments related to the transmission of electromagnetic waves (EL3_K01).				

Basic references:	1. Collin R.E.: Foundations for microwave engineering. IEEE Press, Piscataway, 2001. 2. Dobrowolski J.: Technika wielkich częstotliwości. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2001. 3. Guru B.S., Hiziroglu H.R.: Electromagnetic field theory fundamentals. Cambridge University Press, Cambridge, 2004. 4. Milligan T. A.: Modern antenna design. IEEE Press, J. Wiley-Interscience, Piscataway, 2005. 5. Rosłoniec S.: Podstawy techniki antenowej. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2006. 6. Elliott R. S.: An introduction to guided waves and microwave circuits. Prentice-Hall, New York, 1998. 7. Galwas B.: Podstawy techniki wielkich częstotliwości, published in the Internet.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	homework and a discussion;	L
LO2	homework and a discussion;	L
LO3	homework and a discussion;	L
LO4	discussion;	L
LO5	discussion.	L

Department:	Department of Telecommunications and Electronic Equipment	Tutors:	K. Aniserowicz
Date:	11.12.2014	Coordinator:	**prof. Karol Aniserowicz**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**Control and operation of power systems**				
Module type:	**optional**	Semester: **5**	ECTS: **1**	Module ID:	**ES3D W55 07**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to acquaint students with processes and faults that occur in power systems and the role of supervision and control of power systems; to introduce the controlling methods of active power and frequency, voltage and reactive power; to study the causes of faults and the plans for the defence and restitution of power systems; to acquaint students with the idea of AI application in power system control and operation.				
Assessment:	final written test.				
Module content:	Role and concern of power system control and operation. Control and operation in generation and load nodes. Transfer of data and SCADA systems in power systems. Automatic control of active power and frequency and reactive power and voltage. Selected issues concerning power system defence and restitution. AI techniques in power system control and operation.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has an advanced knowledge of the fundamentals of power system control and operation (EL3_W01);				
LO2	has a good, theoretically based knowledge of the details of power system control (EL3_W02);				
LO3	is able to recognise and formulate complex tasks and problems concerning power system operation and control (EL3_U03);				
LO4	knows how to prepare, publish and present the results of research on power system operation and control (EL3_U06);				
LO5	is able to assess the usefulness and applicability of methods and mathematical models in power system operation and control analysis (EL3_U02, EL3_K01);				
LO6	understands and feels the necessity of to educate new specialists in the field of modern power system operation and control (EL3_K01, EL3_K04).				

Basic references:	1. Korniluk W.: Woliński K.: Elektroenergetyczna automatyka zabezpieczeniowa. Wydawnictwa Politechniki Białostockiej, Białystok, 2012. 2. Machowski J.: Regulacja i stabilność systemu elektroenergetycznego. WNT, Warszawa, 2007. 3. Lubośny Z.: Farmy wiatrowe w systemie elektroenergetycznym. WNT, Warszawa 2009. 4. Pawlik M.: Elektrownie. WNT, Warszawa, 2009. 5. Winkler W., Wiszniewski A.: Automatyka zabezpieczeniowa w systemach elektroenergetycznych. WNT, Warszawa, 1998. 6. Korniluk W.: Automatyka i sterowanie w systemach elektroenergetycznych. Konspekt wykładu w wersji elektronicznej, Politechnika Białostocka, Białystok, 2002. 7. Gonen T.: Electric power distribution system engineering. CRC/Taylor & Francis, Boca Raton, 2008. 8. Crappe M.: Electric power systems. ISTE, Hoboken, 2008.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final written test;	L
LO2	final written test;	L
LO3	final written test;	L
LO4	final written test;	L
LO5	final written test;	L
LO6	final written test.	L

Department:	Department of Electrical Power Engineering, Photonics and Lighting Technology	Tutors:	A. Sobolewski
Date:	5.03.2015	Coordinator:	**Adam Sobolowski, Ph.D.**

Faculty of Electrical Engineering						
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**	
Module name:	**English**					
Module type:	**optional**	Semester:	**5**	ECTS: **1**	Module ID:	**ES3D W55 10**
Number of hours:	L - 0	E - 15	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-					
Aims and objectives:	to develop students' reading and listening skills in English in order to access and interpret the materials necessary in conducting research and teaching students. to help students acquire competences necessary to follow discussions with foreign colleagues, describe research ad write abstracts of scientific papers.					
Assessment:	Graded credit: a term paper (an abstract of a scientific article), a final test.					
Module content:	Collocations in technical English. Academic English. An overview of writing in the sciences. Writing an abstract of a scientific article. Word formation and word families – verbs, adjectives, adverbs, agent and abstract nouns. Grammar issues - strong verbs and active voice. Technical English vocabulary of Greek and Latin origin. English-Polish and Polish-English translations of scientific papers.					
Learning outcomes:	The student who has passed the module assessment:					
LO1	knows extended technical vocabulary and word phrases connected with the specialisation (EL3_W02, EL3_W05, EL3_K01);					
LO2	understands scientific papers, writes an abstract of a scientific paper (EL3_U01, EL3_U06, EL3_U07);					
LO3	knows grammar used in scientific papers (EL3_U01, EL3_K01);					
LO4	translates Polish to English and vice versa (EL3_U07, EL3_K02, EL3_K05).					

Basic references:	1. Macpherson R.: English for Academic Purposes. PWN, Warszawa, 2007. 2. McCarthy M.: Academic vocabulary in use. Cambridge University Press, Cambridge, 2008. 3. Bonamy D.: Technical English 3. Longman-Pearson Education, Essex, 2008. 4. Armer T.: Cambridge English for Scientists. Cambridge University Press, Cambridge, 2012. 5. Ibbotson M.: Cambridge English for Engineering. Cambridge University Press, Cambridge, 2008. 6. Hewings M., Thaine C.: Cambridge Academic English. Cambridge University Press, Cambridge, 2008. 7. MacKenzie I.: Professional English in Use: Engineering. Cambridge University Press, Cambridge, 2009. 8. Chadaj S.: Język angielski zawodowy w branży elektronicznej, informatycznej i elektrycznej. WSiP, Warszawa, 2013. 9. Śleszyńska M.: Get Ready for Technical B2. Politechnika Białostocka, Białystok, 2011. 10. http://online.stanford.edu/Writing_in_the_Sciences_Fall_2014 11. www.uefap.com 12. Specialist and technical dictionaries e.g. www.tech-dict.pl, http://pl.glosbe.com http://megaslownik.pl

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	an academic vocabulary test;	E
LO2	an abstract of a scientific paper;	E
LO3	a grammar test;	E
LO4	oral and written translations of scientific materials.	E

Department:	Foreign Languages Centre	Tutors:	M. Śleszyńska
Date:	30.12.2014	Coordinator:	**Monika Śleszyńska, M.Sc.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Safety and operation of energy systems**				
Module type:	**optional**	Semester: **6**	ECTS: **1**	Module ID:	**ES3D W66 01**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to familiarise students with the following issues: (a) the demand for fuel and energy in the world and in Poland, (b) the methods and operational models of subsystems constituting the national energy systems, (c) the safety of fuel and electricity market, (d) the safety of operation of power systems, (e) ways to protect against the negative impact of electricity infrastructure.				
Assessment:	final written test.				
Module content:	Condition, forecasts and analysis of the demand for fuel and energy in the world and in Poland. Research methods and taxonomic, econometric, cause-and-effect and trend models in the study of structures and forecasting the demand for fuel and energy in the operation of the subsystems constituting the Polish national energy system (Krajowy System Energetyczny - KSE). Security of the national energy system, criteria and safety conditions (status, analysis, forecast). Legal aspects and risk management techniques concerning the operation and safety of the system. Methodology of design of electric-shock protection systems in electrical power systems. Impact of energy infrastructure on the environment and the ways to protect it against the negative effects.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has knowledge of the country's energy security objectives in the aspect of energy policy until 2030 (EL3_W01);				
LO2	has the ability to acquire information relating to the safety of operation of power systems (EL3_U01);				
LO3	is able to critically analyse issues related to the country's energy policy in the areas of functioning and organisation of the fuel supply system (EL3_U02);				
LO4	understands and feels the need for continuous learning in the field of safety and operation of power systems (EL3_K01).				

Basic references:	1. Weron A., Weron R.: Giełda energii elektrycznej - strategia zarządzania rynkiem. Wyd. CIRE, Wrocław, 2000. 2. Malko J., Wilczyński A.: Rynek energii - działania marketingowe. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2006. 3. Dobrzańska I.: Prognozowanie w elektroenergetyce - zagadnienia wybrane. Wydawnictwo Politechniki Częstochowskiej, Częstochowa, 2002. 4. W. Mielczarski, Rynki energii elektrycznej. Wybrane aspekty techniczne i ekonomiczne, Wyd. Agencja Rynku Energii S.A. i Energoprojekt-Consulting S.A., Warszawa 2000. 5. Polityka energetyczna Polski do 2030 roku, Ministerstwo Gospodarki, Rada Ministrów RP, 10.11.2009. 6. Ustawa Prawo energetyczne z dnia 10 kwietnia 1997 r. 7. Bartodziej G., Tomaszewski M.: Polityka energetyczna i bezpieczeństwo energetyczne. Wydawnictwo Nowa Energia, Racibórz, Warszawa, 2009. 8. Biegelmeier G.: Evaluations of effects of sinusoidal alternating current 50/60Hz and direct current on persons with regard to tolerable risk of harmful electric shock. Private non-profit Foundation Electrical Safety, Vienna 2006. 9. Gönen T.: Modern power system analysis. CRC/Taylor & Francis, 2013.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final test;	L
LO2	final test;	L
LO3	final test;	L
LO4	final test.	L

Department:	Department of Electrical Power Engineering, Photonics and Lighting Technology	Tutors:	M. A. Sulkowski
Date:	30.01.2015	Coordinator:	**Marcin A. Sulkowski, Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**Power systems**				
Module type:	**optional**	Semester: **6**	ECTS: **2**	Module ID:	**ES3D W66 02**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0 S – 0
Prerequisites:	-				
Aims and objectives:	to acquaint students with selected problems of planning and development of power systems including the latest trends in this field; to allow students to acquire the skills and competences related to the analysis and synthesis of the operation of power systems, including the reliability of these systems and the possibility of system failures; to familiarise students with the concept of sustainable energy systems and the principles of cross-border cooperation.				
Assessment:	final written test;				
Module content:	Condition and development trends of power systems. Methods of planning for the development of power systems. The impact of new technologies of generation and transmission of electricity on the development of power systems. Reliability of the power system in the new realities. System failures. Defence and the restitution of the power system. Definition of sustainable energy systems and their incorporation into the documents of the EU and national regulations. Indicators of sustainable power systems at the national and local level.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	knows the methods used for the planning of power systems (EL3_W02, EL3_U03);				
LO2	knows and understands the concept of sustainable power systems and indicators of the system (EL3_W02, EL3_U02, EL3_K04);				
LO3	identifies and describes the factors affecting the reliability of the power system and the occurrence of system failures (EL3_U03);				
LO4	assesses and evaluates the use of new technologies for the production of electricity in the planning and development of power systems (EL3_U03).				
Basic references:	1. Machowski J.: Regulacja i stabilność systemu elektroenergetycznego. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2007 2. Szkutnik J.: Perspektywy i kierunki rozwoju systemu elektroenergetycznego: zagadnienia wybrane. Wydawnictwo Politechniki Częstochowskiej, Częstochowa 2011. 3. Kewitt W.: External Costs of Energy – do the Answers Match the Questions? Looking back at ten years of ExternE, Energy Policy, 2005. 4. External Costs Research results on socio-environmental damages due to electricity and transport, European Communities, 2003. 5. Żmuda K.: Elektroenergetyczne układy przesyłowe i rozdzielcze. Wybrane zagadnienia z przykładami. Wydawnictwo Politechniki Śląskiej, Gliwice 2012. 6. Crappe M.: Electric power systems. Wiley, London, Hoboken 2008.				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final written test;	L
LO2	final written test;	L
LO3	final written test;	L
LO4	final written test.	L

Department:	Department of Electrical Power Engineering, Photonics and Lighting Technology	Tutors:	H. Rusak
Date:	19.12.2014	Coordinator:	**Helena Rusak, Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Modelling and study of the phenomena of line-to-earth short-circuit**				
Module type:	**optional**	Semester: **6**	ECTS: **1**	Module ID:	**ES3D W66 03**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to help students understand the issues connected with numerical modelling, experimental field research and computer simulations of single-phase faults in medium and high voltage systems in urban agglomerations.				
Assessment:	final written test.				
Module content:	Circuit diagrams for MV and HV power stations. Operation of neutral points in MV and HV systems. Distribution of ground fault currents in electric power systems. Compensation of ground fault currents in MV systems. Asymmetry of voltage fault. Technical characteristics of high and medium voltage systems and their impact on the effectiveness of electric shock protection in power stations. Causes of electric shock hazard in high and medium voltage systems. Ways to prevent electric shock in energy systems. Criteria for the effectiveness of electric shock protection. Test methods and requirements for the fault impedance in electrical systems. Discussion of the results of a selected piece of field research.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has a detailed theoretical knowledge of line-to-earth short-circuit and the accompanying phenomena and the methods of studying them (EL3_W02);				
LO2	is able to characterise the phenomena associated with short circuits and to apply selected advanced methods of modelling of these phenomena (EL3_U06);				
LO3	is able to use his/her knowledge to make a critical evaluation of the results of research pertaining to the study and modelling of the phenomena of short circuits (EL3_U01, EL3_U02);				
LO4	can think and act in an independent and creative way using selected methods of modelling and analysing of short-circuits (EL3_K03).				

Basic references:	1. Kacejko P., Machowski J.: Zwarcia w sieciach elektroenergetycznych. WNT, Warszawa, 2000. 2. Markiewicz H.: Bezpieczeństwo w elektroenergetyce. WNT, Warszawa, 2009. 3. Skliński R.: Zagrożenie porażeniem prądem elektrycznym w stacjach elektroenergetycznych. Wydawnictwo Politechniki Białostockiej, Białystok, 2009. 4. Chwaleba A., Machowski J., Siedlecki A.: Metrologia elektryczna. WNT, Warszawa, 2000. 5. Markiewicz H.: Urządzenia elektroenergetyczne. WNT, Warszawa, 2001. 6. Gönen T.: Modern power system analysis, CRC/Taylor & Francis, 2013. 7. IEEE recommended practice for grounding of industrial and commercial power systems. The Institute of Electrical and Electronics Engineers, New York, 1992. 8. Morrison R.: Grounding and shielding in facilities. J. Wiley & Sons, New York, 1990.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final test;	L
LO2	final test;	L
LO3	final test;	L
LO4	final test.	L

Department:	Department of Electrical Power Engineering, Photonics and Lighting Technology	Tutors:	M. A. Sulkowski
Date:	30.01.2015	Coordinator:	**Marcin A. Sulkowski, Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Optical fibers technology**				
Module type:	**optional**	Semester: **6**	ECTS: **2**	Module ID:	**ES3D W66 04**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to acquaint students with the methods of analysis of electromagnetic wave propagation in optical fibers; to acquaint students with the methods of manufacturing of optical fibers; to acquaint students with optical fiber telecommunication systems, the principles of the long-range optical fiber connections, optical fiber medium-range links, local fiber networks and to explain the measurement of their parameters. to discuss the latest trends and possible applications of optical fiber technology.				
Assessment:	final written test.				
Module content:	Characteristics of modern optical fibers. Prospects for the development of optical fiber technology. Electromagnetic wave propagation in optical fibers. Methods of production of optical fibers. Types of telecommunication networks. Optical links – transmission rate. Optical transmitters. Photodetectors in optical communication. Types and applications of optical amplifiers. Multiplexing optical signal. Optical fiber cables. Types of optical fiber connections. Monitoring equipment for optical fiber networks. Examples of solutions in waveguide structures.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	analyses electromagnetic wave propagation in optical fibers (EL3_W01, EL3_W02);				
LO2	lists and describes the operating principles of fiber-optic systems (EL3_W02, EL3_U01);				
LO3	classifies signal transmission systems in fiber-optic networks (EL3_U02);				
LO4	classifies tracking and diagnostic devices in fiber-optic networks (EL3_U02);				
LO5	indicates the trends of development and application capabilities of optical fiber technology (EL3_U03, EL3_K01).				
Basic references:	1. Dorosz J.: Technologia światłowodów włóknistych. Wydawnictwo PTCer., Kraków, 2005. 2. John M. Senior: Optical Fiber Communications Principles and Practice, Pearson Education Limited 2009. 3. Safa O. Kasap: Optoelectronics and Photonics: Principles and Practices, Prentice Hall, 2001. 4. Sohail Anwar, M. Yasin Akhtar Raja, Salahuddin Qazi, Mohammad Ilyas, Nanotechnology for Telecommunications, CRC Press, 2010.				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final written test;	L
LO2	final written test;	L
LO3	final written test;	L
LO4	final written test;	L
LO5	final written test.	L

Department:	Department of Electrical Power Engineering, Photonics and Lighting Technology	Tutors:	J. Dorosz
Date:	30.12.2014	Coordinator:	**prof. Jan Dorosz**

Faculty of Electrical Engineering						
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**	
Module name:	**Nanotechnology**					
Module type:	**optional**	Semester:	**6**	ECTS:	**2**	Module ID: **ES3D W66 05**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-					
Aims and objectives:	to acquaint students with the types and applications of nanometric structures and the technology of their manufacturing; to teach students how to operate the apparatus for the measurement and modification of nanomaterials; to familiarise students with the properties of nanomaterials: nanotubes, quantum dots, photonic crystals, electronic systems using nanometric layers and connections; to acquaint students with the prospects of development of nanotechnology.					
Assessment:	final written test.					
Module content:	Applications of nanotechnology. Trends in the development of nanotechnology. Example properties of materials which use nanostructures. Technologies of manufacturing of nanostructures. Design and operation of the apparatus for the measurement and modification of nanomaterials: electron microscopy (TEM), scanning microscopy (SEM, EDS), scanning probes (STM, AFM). Characteristics of nanomaterials: nanotubes, quantum dots, photonic crystals, electronic systems using nanometric layers and connections. Nanostructures used in photonics.					
Learning outcomes:	The student who has passed the module assessment:					
LO1	discusses the types and applications of nanostructures (EL3_W01, EL3_W02);					
LO2	describes methods of manufacturing of nanostructures: MBE, MOCVD, nanolithography (EL3_W02, EL3_U01);					
LO3	discusses the operating principles of the apparatus for the measurement and modification of nanomaterials (EL3_W02, EL3_U02);					
LO4	describes the properties of nanomaterials: nanotubes, quantum dots, photonic crystals, electronic systems using nanometric layers and connections (EL3_W02, EL3_U01, EL3_U03);					
LO5	indicates prospects for the development of nanotechnology (EL3_K01).					

Basic references:	1. Sohail Anwar, M. Yasin Akhtar Raja, Salahuddin Qazi, Mohammad Ilyas, Nanotechnology for Telecommunications, CRC Press, 2010. 2. Safa O. Kasap, Principles of electronic materials and devices, McGraw-Hill, 2006. 3. Diaspro A.: Nanoscopy and multidimensional optical fluorescence microscopy. CRC/Taylor & Francis, Boca Rayton, 2010. 4. Nobuyoshi Koshida: Device applications of silicon nanocrystals and nanostructures. Springer, New York, 2009. 5. Pampuch R.: Everyday uses of ceramics materials, Crakow, 2009. 6. Liu G,. Jacquier B.: Spectroscopic properties of rare earth in optical materials. Springer, Berlin, 2004. 7. Fenglian Bai, Xiong Gong, Xiaowei Zhan, Hongbing Fu, Thomas Bjornholm, Organic Optoelectronics, John Wiley & Sons, 2013.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	final written test;	L
LO2	final written test;	L
LO3	final written test;	L
LO4	final written test;	L
LO5	final written test.	L

Department:	Department of Electrical Power Engineering, Photonics and Lighting Technology	Tutors:	D. Dorosz
Date:	30.12.2014	Coordinator:	**prof. Dominik Dorosz**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**Power electronics in smart grids**				
Module type:	**optional**	Semester: **6**	ECTS: **2**	Module ID:	**ES3D W66 06**
Number of hours:	L - 30	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to familiarise students with the properties of 1- and 3-phase power converters: AC/DC, DC/AC, DC/DC and AC/AC used in smart grids and cooperating with renewable energy sources as well as to talk over their basic control methods.				
Assessment:	Oral or written exam				
Module content:	Smart grid (SG) – the state of the art, problems and tasks. Concept of the smart grid. Power electronics devices used in the SG. Converters used to transmit energy by DC high voltage (HVDC). Converters used to connect water and wind generators, solar cells and fuel cells with the power network. Systems for the cooperation of wind and water turbines with different types of generators (asynchronous squirrel-cage generator, asynchronous wound-rotor generator, synchronous generator). AC/DC converters used for the cooperation of DC sources with the power network. Influence of grid parameters (dips, phase and frequency asymmetries, frequency changes) on the control and operation of AC/DC converters. Converters used in photovoltaic systems. Converter systems for energy (kinetic and electric) accumulation. Hierarchical structure of AC and DC connection in dispersed network. Deformations of current and voltage issues in power networks as well as devices for their elimination (passive filters, controlled induction, and series, parallel and mixed active filters). High frequency smart energy transformers. Vehicle to grid (V2G) and vehicle to home (V2H) systems.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has an advanced knowledge concerning the construction and analysis of power electronic devices (EL3_W01);				
LO2	has theoretical knowledge acquired from scientific publications concerning the construction of power electronic converters and their use in smart grids (EL3_W02);				
LO3	can gain information concerning power electronic devices, make its selection and interpretation (EL3_U01);				
LO4	understands and feels the need for increasing his or her competence concerning the subject matter, especially the construction, requirements and utilisation of power electronic devices (EL3_K01).				

Basic references:	1. Sood Vijay K.: HVDC and FACTS controllers. Kluwer Academic Publishers, Boston, 2004. 2. Gellings C. W.: The smart grids: enabling energy efficiency and response. The Fairmont Press, 2009. 3. Bin Wo: Power conversion and control of wind energy system. John Wiley & Sons, New York, 2011. 4. Benysek G.: Improvement in the quality of delivery of electrical energy using power electronic systems. Springer, London, 2007. 5. Barlik R. et all. : Poradnik inżyniera energoelektronika (in Polish). PWN, 2013. 6. Strzelecki R., Benysek G.: Power electronics in smart electrical energy networks. Springer, London, 2008. 7. Strzelecki R., Benysek G.: Przegląd Elektrotechniczny ISSN 0033-2097, R. 85 nr 11/2009.	
	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	oral or written exam;	L
LO2	oral or written exam;	L
LO3	oral or written exam;	L
LO4	oral or written exam.	L
Department:	Department of Power Electronics and Electric Drives	Tutors: A. Sikorski
Date:	14.01.2015	Coordinator: **prof. Andrzej Sikorski**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**Effects of electromagnetic fields on living organisms**				
Module type:	**optional**	Semester: **6**	ECTS: **1**	Module ID:	**ES3D W66 07**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to familiarise students with the mechanisms of interaction of living organisms and non-ionising electromagnetic radiation; to familiarise students with domestic and international regulations in the subject matter; to enable students to acquire the ability to assess actual, rather than mythological, radiation hazard and to select appropriate methods of protection.				
Assessment:	homework and discussion.				
Module content:	Mechanisms of interaction of electromagnetic fields and the human body according to the International Commission on Non-Ionising Radiation Protection (ICNIRP): the effects of low-frequency electric fields, low-frequency magnetic fields, and energy absorption of radio-frequency and microwave electromagnetic fields. Effects of long-term exposure: real diseases and myths. Phenomena under which the rules concerning exposure limits are formulated. Epidemiological studies and experiments on laboratory animals. Concept of SAR. International (EU) and national regulations on exposure limits. Comparison of the levels that are considered to be harmful. Reasons for significant discrepancies of assessments and the resulting opportunity for cheats and scandalmongers. Positive effects of electromagnetic fields on human body and their application in medicine: therapy and rehabilitation. The necessity of providing proper information to the public in order to minimise the impact of myths created by ignorant, irresponsible people, and sensation-hungry media. Information ethics.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has a good theoretical knowledge on the interaction of electromagnetic fields and living organisms (EL3_W02);				
LO2	can effectively gain information related to the effects of electromagnetic fields on humans from various sources, including publications in foreign languages, and make a proper selection and interpretation of this information (EL3_U01);				
LO3	can recognise and formulate complex tasks and problems associated with the effects of electromagnetic fields on humans (EL3_U03);				
LO4	understands and feels the necessity of lifelong learning, and analysing the latest research related to the impact of electromagnetic fields on humans (EL3_K01);				
LO5	is aware of the importance of behaving in a professional manner and respecting the rules of professional ethics, as well as creating the ethos of scientific and professional communities, in particular with regards to the effects of electromagnetic fields on living organisms (EL3_K02);				
LO6	is aware of the social role of a doctoral graduate, understands the need for providing the public with information and opinions on the impact of electromagnetic fields on health (EL3_K05).				

Basic references:	1. ICNIRP: Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Physics, v. 74, no 4, 1998. 2. Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (1999/519/EC), Official Journal of the European Communities L199 of 30.7.1999. 3. Directive 2004/40/EC of the European Parliament and of the Council of 29 April 2004 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields), Official Journal of the European Union L159 of 30.04.2004. 4. Regulation of the Polish Minister of the Environment of 30.10.2003 on permissible levels of electromagnetic fields in the environment and ways of verification of meeting these levels (in Polish). Dz. U. 2003 nr 192 poz. 1883. 5. Regulation of the Polish Minister of Labour and Social Policy of 29.11.2002 on the maximum permissible concentration and intensity of harmful factors in the work environment (in Polish). Dz. U. 2002 nr 217 poz. 1833. 6. Thuery J.: Microwaves. Industrial, scientific and medical applications. Artech House, Boston, 1992. 7. Internet site of the World Health Organisation: http://www.who.int/en/. 8. Internet site of the ICNIRP: http://www.icnirp.de/.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	homework and discussion;	L
LO2	homework and discussion;	L
LO3	homework and discussion;	L
LO4	interaction during the course and discussion;	L
LO5	interaction during the course and discussion;	L
LO6	interaction during the course and discussion.	L

Department:	Department of Telecommunications and Electronic Equipment	Tutors:	K. Aniserowicz
Date:	11.12.2014	Coordinator:	**prof. Karol Aniserowicz**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**
Module name:	**English**				
Module type:	**optional**	Semester: **6**	ECTS: **1**	Module ID:	**ES3D O66 10**
Number of hours:	L - 0	E - 15	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to develop students' reading and listening skills in English in order to access and interpret the materials necessary in conducting research and teaching students. to help students acquire competences necessary to follow discussions with foreign colleagues and give presentations.				
Assessment:	a multimedia presentation, a final test.				
Module content:	Presentations in English – a clear layout, linking words; giving a paper at a conference. Profiles, organising CVs and cover letters, planning a career path, applying for a job. English-Polish and Polish-English translations of scientific papers.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	makes multimedia presentations (EL3_U07);				
LO2	knows grammar used in scientific papers (EL3_U01, EL3_K01);				
LO3	translates Polish to English and vice versa (EL3_U07, EL3_K02, EL3_K05).				
Basic references:	1. Macpherson R.: English for Academic Purposes. PWN, Warszawa, 2007. 2. McCarthy M.: Academic vocabulary in use. Cambridge University Press, Cambridge, 2008. 3. Bonamy D.: Technical English 3. Longman-Pearson Education, Essex, 2008. 4. Armer T.: Cambridge English for Scientists. Cambridge University Press, Cambridge, 2012. 5. Ibbotson M.: Cambridge English for Engineering. Cambridge University Press, Cambridge, 2008. 6. Hewings M., Thaine C.: Cambridge Academic English, Cambridge University Press, Cambridge, 2008. 7. MacKenzie I.: Professional English in Use: Engineering. Cambridge University Press, Cambridge, 2009. 8. Burton G.: Presenting. Deliver presentations with confidence. HarperCollins Publishers, London, 2013. 9. Chadaj S.: Język angielski zawodowy w branży elektronicznej, informatycznej i elektrycznej. WSiP, Warszawa, 2013. 10. Śleszyńska M.: Get Ready for Technical B2. Politechnika Białostocka, Białystok, 2011. 11. http://online.stanford.edu/Writing_in_the_Sciences_Fall_2014 12. www.uefap.com 13. Specialist and technical dictionaries e.g. www.tech-dict.pl, http://pl.glosbe.com http://megaslownik.pl.				

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	a multimedia presentation;	E
LO2	a grammar test;	E
LO3	oral and written translations of scientific materials.	E

Department:	Foreign Languages Centre	Tutors:	M. Śleszyńska
Date:	30.12.2014	Coordinator:	**Monika Śleszyńska, M.Sc.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Interpersonal communication**				
Module type:	**optional**	Semester: **7**	ECTS: **1**	Module ID:	**ES3D W77 01**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to convey to PhD students practical information in the field of interpersonal communication that is relevant to the effective functioning of the educational process. to develop students' ability to analyse and interpret various aspects of communication in the teaching process, in the context of psychological properties and social functioning of humans. to develop students' social skills through the transfer of knowledge of teamwork and communication within a team and by engaging the students in teamwork and group discussions.				
Assessment:	written test; assessment of students' participation in class discussions.				
Module content:	Objectives and barriers in interpersonal communication taking into account the situation of teaching. Empathy, assertiveness and active listening as communication platforms. Non-verbal communication, self-awareness in communication and self-presentation. Difficulties (conflicts) in the communication process (causes, course, and the ways to overcome them). Techniques and methods of social influence in interpersonal interactions during the learning process. Manipulation and defence techniques. Intercultural communication - barriers and its importance in the modern world.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	has the theoretical basis of interpersonal communication (EL3_W06);				
LO2	is able to identify communication difficulties in the process of teaching and apply modern techniques which contribute to their liquidation (EL3_U07, EL3_U08);				
LO3	can apply the techniques of social impact contributing to the elimination of emotional stress and affect the quality of interpersonal relations (EL3_U08, EL3_K05);				
LO4	can work in a research team, initiate students teamwork and lead the team effectively, uses modern techniques in his/her work with a group (EL3_U05, EL3_K02);				
LO5	is able to communicate with students and maintain positive interpersonal relationships (EL3_U07, EL3_K02);				
LO6	understands and feels the need for continuous improvement in the field of interpersonal communication taking into account the characteristics of the educational process and the ethical issues of interpersonal contacts (EL3_K01).				

Basic references:	1. Alberti R.: Asertywność: sięgnij po to czego chcesz nie raniąc innych, Wyd. GWP, Gdańsk, 2007. 2. Gesteland R.R.: Różnice kulturowe a zachowania w biznesie. WN PWN, Warszawa, 2000. 3. Leary M. R.: Wywieranie wrażenia na innych: o sztuce autoprezentacji. GWP, Gdańsk, 2005. 4. McKay, Davis M., Fanning P.: Sztuka skutecznego porozumiewania się. GWP, Gdańsk 2013. 5. Pease A. B.: Mowa ciała w pracy. Wyd. Rebis, Poznań 2011. 6. Binsztok A. (red.): Sztuka skutecznego prowadzenia mediacji i negocjacji. Wyd. Marina, Wrocław 2013. 7. Tokarz M.: Argumentacja, perswazja, manipulacja. Wyd. GWP, Gdańsk 2008. 8. www.helpguide.org/relationships 9. Wood J. : Interpersonal communication: everyday encounters. Cengage Learning, 2015. 10. Solomon D., Theiss J.: Interpersonal communication: putting theory into practice. Routledge, 04.01.2013 11. Antos G., Ventola E.: Handbook of interpersonal communication (e-book). Walter de Gruyter, 2008.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written test based on lectures;	L
LO2	written test based on lectures;	L
LO3	written test based on lectures;	L
LO4	discussion based on the didactic experience of students;	L
LO5	discussion based on the didactic experience of students;	L
LO6	discussion based on the didactic experience of students.	L

Department:	Faculty of Management, Department of Economics and Social Sciences	Tutors:	A. Borowska
Date:	10.12.2014	Coordinator:	**Alina Borowska, Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Determinants of enterprise competitiveness**				
Module type:	**optional**	Semester: **7**	ECTS: **1**	Module ID:	**ES3D W77 02**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to acquaint students with the problems concerning effective enterprise activity in the conditions of domestic and international competition. to develop students' ability to verify the potential of an enterprise and its key competences which condition the possibility of building competitive advantage.				
Assessment:	written test and students' participation in discussions.				
Module content:	Classification of enterprises. Notion of competitiveness with regard to the three levels: micro-, mezzo- and macroeconomic. Instruments for enterprise competitiveness. Internationalisation of an enterprise. Functions of international entrepreneurship. Globalised competition as a challenge for an enterprise. International corporations and direct foreign investments as globalisation mechanisms. Resource conditioned competition and its stimulating factors. The essence, kinds and sources of enterprise competitive advantage. Competitiveness in the theory of comparative costs. Directions and means of strengthening enterprise competitiveness. Innovations, intellectual capital, technological advancement and the Internet as the determinants of international competitiveness of an enterprise.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	defines the terms connected with enterprise and competitiveness (EL3_W04, EL3_W05);				
LO2	evaluates and justifies the choice of factors conditioning enterprise competitiveness on the international arena (EL3_U05, EL3_K02);				
LO3	identifies the entities of the international market (EL3_W04);				
LO4	selects and indicates effective components of the competitive potential of an enterprise (EL3_W04, EL3_W05, EL3_K01, EL3_K02).				

Basic references:	1. Bogdanienko J.: Uwarunkowania budowania konkurencyjności przedsiębiorstw w otoczeniu globalnym. Wydawnictwo Naukowe "Adam Marszałek", Toruń, 2007. 2. Juchniewicz M.: Zarządzanie przedsiębiorstwem w warunkach konkurencji. Determinanty konkurencyjności przedsiębiorstw. Wydawnictwo Uniwersytetu Warmińsko-Mazurskiego, Olsztyn, 2006. 3. Majchrzak M.: Konkurencyjność przedsiębiorstw podsektora usług biznesowych w Polsce. Perspektywa mikro-, mezo-, mikroekonomiczna. CeDeWu, Warszawa, 2012. 4. Morawczyński R.: Przedsiębiorczość międzynarodowa. Wydawnictwo Uniwersytetu Ekonomicznego w Krakowie, Kraków, 2008. 5. Stankiewicz M. J.: Determinanty konkurencyjności polskich przedsiębiorstw. Sposoby i warunki umacniania konkurencyjności przedsiębiorstw w perspektywie globalizacji gospodarki. Wydawnictwo Uniwersytetu Mikołaja Kopernika, Toruń, 2002. 6. Stankiewicz M. J.: Konkurencyjność przedsiębiorstwa. Budowanie konkurencyjności przedsiębiorstwa w warunkach globalizacji. Wydawnictwo TNOiK, Toruń, 2005. 7. Śliwiński R.: Kluczowe czynniki międzynarodowej konkurencyjności przedsiębiorstw. Wydawnictwo Uniwersytetu w Poznaniu, Poznań, 2011. 8. Aaker D. A.: Brand relevance: making competitors irrelevant. Jossey-Bass, San Francisco 2011. 9. Skąpska E.: Development of the service sector in Poland at the turn of the century: tendencies, determinants prospects (chapters 3, 4, 5). LAP Lambert Academic Publishing, Saarbrucken 2014.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written test;	L
LO2	participation in discussions;	L
LO3	written test;	L
LO4	participation in discussions.	L

Department:	Faculty of Management, Department of Economics and Social Sciences	Tutors:	E. Skąpska
Date:	30.01.2015	Coordinator:	**Elżbieta Skąpska, Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Modern theories of enterprise and factors of production**				
Module type:	**optional**	Semester: **7**	ECTS: **1**	Module ID:	**ES3D W77 03**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to familiarise doctoral students with modern theories of enterprise and factors of production; to develop students' skills of creative thinking.				
Assessment:	written test based on the lectures.				
Module content:	Current definitions connected with an enterprise and its environment. A model concept of an enterprise. The essence and scope of an enterprise. Classification of enterprises. Legal and organisational forms. Enterprise potential. Concept of an enterprise based on the resources of production factors. Modern approach towards managing the resources. Outline of traditional theories on enterprise and production factors. Controversy around the neoclassical theory of enterprise. Reasons for the rise of alternative theories. Perfect competition and monopoly – modern model approach. Theories of oligopoly. Manager theories. Maximisation of profit. An entrepreneur as an innovator. Concept of transaction cost. Institutional theories of enterprise. Contract theories as a development of the institutional approach. Agency theory. Behavioural theories of enterprise. Life cycle of an enterprise. Key methods of managing a 21st century enterprise. Taking advantage of production factors. Internationalisation and globalisation of an enterprise. Flow of production factors. Essence and tendencies of shaping an enterprise (an organisation) of the future.				
Learning outcomes:	The student who has passed the module assessment:				
LO1	explains cause-and-effect phenomena connected with the life cycle of an enterprise (EL3_W04, EL3_W05);				
LO2	recognises types of enterprises (EL3_W04);				
LO3	differentiates forms of market competition (EL3_K01, EL3_K02);				
LO4	interprets different concepts of an enterprise (EL3_W05, EL3_K02).				

Basic references:	1. Brzeziński M.: Wprowadzenie do nauki o przedsiębiorstwie. Difin, Warszawa, 2007. 2. Drucker P. F.: Natchnienie i fart czyli innowacja i przedsiębiorczość. Wyd. Studio Emka, Warszawa, 2004. 3. Gruszecki T.: Współczesne teorie przedsiębiorstwa. PWN, Warszawa, 2002. 4. Kasiewicz S., Możaryna H.: Teoria przedsiębiorstwa. SGH, Warszawa, 2004. 5. Miroński J.: Zarys teorii przedsiębiorstwa opartej na władzy. SGH, Warszawa, 2004. 6. Schroeder J., Śliwiński R.: Przedsiębiorstwo na rynku globalnym. Wyd. Uniwersytetu Ekonomicznego w Poznaniu, Poznań 2013. 7. Żurek J.: Przedsiębiorstwo: zasady działania, funkcjonowanie, rozwój. Fundacja Uniwersytetu Gdańskiego, Gdańsk, 2007. 8. Smith A.: Best commercial practice: business theory a practice. Recanati, 2013. 9. Szczepański M. (ed.): Economic and social aspects of modern enterprises. Publishing House of Poznan University of Technology, Poznań, 2010.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written test;	L
LO2	written test;	L
LO3	written test;	L
LO4	written test.	L

Department:	Faculty of Management, Department of Economics and Social Sciences	Tutors:	E. Skąpska
Date:	30.01.2015	Coordinator:	**Elżbieta Skąpska, Ph.D.**

Faculty of Electrical Engineering					
Study programme:	**electrotechnics**		Degree level and type:	**PhD degree, full time**	
Module name:	**Economy**				
Module type:	**optional**	Semester: **7**	ECTS: **1**	Module ID:	**ES3D W77 04**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-				
Aims and objectives:	to familiarise students with basic laws of economics and relationships in the economy; to enable students to acquire skills of diagnosing economic situation and determining appropriate actions at the enterprise level after the initial analysis and evaluation of the economic situation; to help students learn how to use basic economic categories precisely; to acquaint students with the knowledge necessary to analyse the behaviour of operators on the market; to familiarise students with the functioning of the national and international economy, individual markets products, services, factors of production and financial markets; to educate the ability to identify the causes and effects of various phenomena in the contemporary economic reality, to receive and understand market signals in a selected industry, and to establish a link between changes in the macroeconomic environment and the decisions of the companies in this industry.				
Assessment:	written test.				

Module content:	Management process, the problem of choice, opportunity cost, profitability, efficiency, economic rationality, optimality. Basic theory of the market; supply and demand and their determinants. Consumer market. Manufacturer market. Market equilibrium, the equilibrium price. Forms and effects of market regulation. Company in a market economy (organisational and legal forms, objectives). Choice of production structure. Choice of production technology. Revenue features in the short term. Flexibility: price, income and mixed demand and their role in the decisions of an entrepreneur. Price elasticity of supply. Elasticity of demand and supply and production tax policy. Elements of economic analysis of a company functioning in a competitive market and a monopoly (cost functions, profitability thresholds, technical and economic optimum, decisions on production volumes). Efficiency of competitive market vs. captive market. Advantages and disadvantages of scale and the form of organisation of the market. Gross domestic product, gross national product, national income. Economic growth and development. Sustainable development. Measuring the level and quality of life. Goods market (macroeconomic supply and demand curves, macroeconomic balance). Factors of economic growth. Business cycle. Conceptions of the role of state in the economy (content and form of interventionism) - liberalism and Keynesianism. State budget and fiscal policy. Taxes and taxation systems. Budget deficit and public debt. Monetary-credit and monetary policy. Money market (supply and demand, money creation). Relationship between goods market and money market (transmission mechanism and the effect of crowding out). Inflation: measurement, causes and effects. Labour market: supply and demand for labour. Unemployment according to the classics, and according to Keynesians. Relationship between unemployment and the rate of inflation. Interdependence of the three markets; goods market, money market and labour market. Main instruments of trade policy. Exchange rate. Country's balance of payments. Foreign exchange reserves and changes in the level of these reserves. Globalisation and regional economic integration.
Learning outcomes:	The student who has passed the module assessment:
LO1	has a basic knowledge of the most important economic theories, makes a descriptive analysis of the behaviour of traders (EL3_W04);
LO2	describes the relationship between changes in the macroeconomic environment and the decisions of the company (EL3_K01, EL3_K03);
LO3	explains the basic principles of economy and economic policy (EL3_K02, EL3_K05);
LO4	describes how the following markets work: products, services, and finance market (EL3_K05).

Basic references:	1. Milewski R. (red.): Podstawy ekonomii, PWN, Warszawa, 2013. 2. Samuelson P. A., Nordhaus W.D.: Ekonomia, Rebis, Poznań, 2012. 3. Marciniak S.: Makro- i mikroekonomia, Podstawowe problemy współczesności, PWN, Warszawa 2013. 4. Hall R. E., Taylor J. B.: Makroekonomia, PWN, Warszawa, 2005. 5. Begg D., Fischer S., Dornbusch R.: Economics, McGraw-Hill, London, 2005. 6. Walter J. Wessels: Economics. Barron's Educational Series, 2000. 7. Kiyosaki R. T.: Spisek bogatych: osiem nowych zasad rządzących pieniędzmi, Instytut Praktycznej Edukacji, Osielsko, 2010. 8. Giddens A.: Europa w epoce globalnej, PWN, Warszawa, 2009. 9. Smith A.: Badania nad naturą i przyczynami bogactwa narodów, PWN, Warszawa 2013. 10. Pysz P., Grabska A.E., Moszyński M.: Ład gospodarczy a współczesna ekonomia, PWN, Warszawa, 2014.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1	written test;	L
LO2	written test and participation in the discussion;	L
LO3	written test and participation in the discussion;	L
LO4	written test.	L

Department:	Faculty of Management Department of Tourism Economy	Tutors:	E. Szymańska
Date:	12.12.2014	Coordinator:	**Elżbieta Szymańska, D.Sc., Ph.D.**

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Szablon

Faculty of Electrical Engineering						
Study programme:	**electrotechnics**			Degree level and type:	**PhD degree, full time**	
Module name:	**Title of the course**					
Module type:	**optional**	Semester:	**1**	ECTS:	**1**	Module ID: **ES3D O22 01**
Number of hours:	L - 15	E - 0	LC - 0	P - 0	SW - 0	S – 0
Prerequisites:	-					
Aims and objectives:						
Assessment:						
Module content:						

Learning outcomes:	The student who has passed the module assessment:
LO1	
LO2	
LO3	
LO4	
LO5	
LO6	

Basic references:	1. I. Nazwisko: Tytuł. Wydawnictwo, Miejsce wydania, rok.

	Methods of assessing a learning outcome:	Type of class where the outcomes are assessed
LO1		L
LO2		L
LO3		L
LO4		L
LO5		L

LO6			L
Department:	Department ...	Tutors:	wpisz osoby prowadzące
Date:	dd.mm.rrrr	Coordinator:	**tytuł/stopień imię i nazwisko**