STUDY MODULE DESCRIPTION FORM

Name of the module/subject		Code
Electrical machines		**1010311331010320050**

Field of study	Profile of study (general academic, practical)	Year /Semester
Power Engineering	**(brak)**	**2 / 3**
Elective path/specialty	Subject offered in:	Course (compulsory, elective)
-	**polish**	**obligatory**

Cycle of study:	Form of study (full-time,part-time)
First-cycle studies	**full-time**

No. of hours					No. of credits
Lecture: **2**	Classes: **-**	Laboratory: **1**	Project/seminars: **-**		**4**

Status of the course in the study program (Basic, major, other)	(university-wide, from another field)
(brak)	**(brak)**

Education areas and fields of science and art	ECTS distribution (number and %)
technical sciences	**4 100%**

Responsible for subject / lecturer:

dr hab. inż. Stanisław Rawicki, prof.PP
email: Stanislaw.Rawicki@put.poznan.pl
tel. 61 665 2595
Faculty of Electrical Engineering
ul. Piotrowo 3A, 60-965 Poznań

Responsible for subject / lecturer:

dr inż. Jacek Mikołajewicz
email: Jacek.Mikolajewicz@put.poznan.pl
tel. 61 665 2396
Faculty of Electrical Engineering
ul. Piotrowo 3A, 60-965 Poznań

Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Basic knowledge of electromagnetism and electrical circuits analysis.
2	**Skills**	Skill of analysis of simple electrical circuits of two degrees of freedom and solving systems of differential linear equations.
3	**Social competencies**	Awareness of necessity of knowledge and skills extension. Ability to submission to rules standing during lectures in big group. Skill of communication with the cooperating students and lecturers.

Assumptions and objectives of the course:

Learning of construction, principles of operation, characteristics, exploitation properties and basic methods of analysis of typical operation states of transformers and induction machines. Learning of basic methods of calculation of magnetic circuits in electromagnetic converters.

Getting to know construction, principles of operation, characteristics, exploitation properties and basic methods of analysis of typical operation states of synchronous, commutator and special machines. Learning the fundamental methods of investigation and measurements of electrical machines.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. Knowledge of: 1) operation of elements and electric, mechanical, analog and digital systems; knowledge of physical phenomena occurring in such systems; 2) analysis of operation of power electrical engineering systems; 3) mathematical description of physical, chemical and energetistic processes. - [K_W01++]

2. Knowledge of mechanics, thermodynamics, fluid mechanics, electricity and magnetism, optics, nuclear physics, solid-state physics; knowledge necessary to understanding of physical phenomena in electric, energetistic, electronic elements and systems allowing for their surroundings. - [K_W02++]

3. Well-ordered knowledge within electric, electronic and power engineering electronics circuits theory; knowledge of signals theory and method of signals conversion. - [K_W17++]

Skills:

1. elaborate documentation relating to realization of an engineering problem and prepare the text containing discussion of results of this problem realization - [K_U03++]

2. compare design solutions of elements and electric circuits according to the given utilizable and economic criteria (for example: power consumption, operation rate, cost) - [K_U08++]

3. use properly chosen methods and devices making possible measurement of basic quantities characterizing elements and systems of power engineering - [K_U10++]

Social competencies:

1. have awareness of importance and understand non-technical aspects and results of activity of power electrical engineer; here also understand activity influence on environment and responsibility for the taken decisions - [K_K02++]
2. have awareness of responsibility for the own work and willingness of submission to rules of work in team and bear responsibility for jointly realized problems - [K_K04++]

Assessment methods of study outcomes

Lectures:

? evaluation of knowledge and skills presented in the written exam,

Laboratory classes:

? test and awarding knowledge during realization of laboratory classes on electrical machines,

? evaluation of student activity and appraisal both of increase of his knowledge, skills and social competences connected with activities in teamwork,

? evaluation of knowledge and skills related to the individual laboratory class, appraisal of the report.

Obtainment of the additional points in connection with activity, in particular:

? preparation of answers on questions and problems given by the lecturer,

? skill of co-operation in the teamwork in laboratory,

? annotations connected with improvement of didactic materials,

? care and aesthetics of reports and problems elaborations within own learning.

Course description

Magnetic circuits. Transformers ? no-load state, equivalent circuit, transformer operation at load, three-phase transformers, parallel operation, selected transient states. The elements of electromagnetic energy conversion. Electrical machines ? fundamental definitions: distributed windings, rotating magnetic fields, electromotive force induced by rotating magnetic fields, winding factors. Induction machines: construction and principle of operation, equivalent circuit, dependence of torque on rotational speed, machines with cage rotor, skin effect in bars, speed control. Starting and braking operation of induction machine. Single-phase induction motors. Induction generator. Synchronous machines: construction and principle of operation, vector diagram, equivalent circuit, no-load and short-circuit of synchronous generator, steady-state characteristics, salient-pole machines, synchronous machine operation in power network, machines with permanent magnets, starting of synchronous motors, damping windings, selected transient states. Stepper motors. Direct-current commutator machines: construction and principle of operation, connection systems of windings, magnetic field in air-gap, armature reaction, commutation, compensating winding, generator characteristics, motor characteristics, control of motor speed, selected transient states. Alternating-current commutator motors. Brushless direct-current machines. Servo-motors. Investigations and measurements of electrical machines. Determination of parameters and characteristics of electrical machines on the ground of measurements.

Basic bibliography:

1. 1. A. M. Plamitzer, Maszyny Elektryczne, wyd. VII, WNT Warszawa, 1982.

2. 2. W. Karwacki, Maszyny Elektryczne, Wyd. Pol. Wrocławskiej, Wrocław, 1993.

3. 3. M. S. Sarma, Electric Machines, Steady-State Theory and Dynamic Performance, West Publishing Company, wyd. 2, 1994 i wyd. następne.

Additional bibliography:

1. 1. W. Latek, Teoria Maszyn Elektrycznych, wyd. II, WNT Warszawa, 1987.

2. 2. Praca zbiorowa, Poradnik Inżyniera Elektryka, Tom 2, WNT Warszawa 2007.

Result of average student's workload

Activity	Time (working hours)
1. participation in lectures	30
2. participation in laboratory classes	15
3. participation in consultations related to lectures and laboratory classes	6
4. preparation to laboratory classes	20
5. completion (at home) of laboratory classes (for example - elaboration of the report)	8
6. preparation to the written test	22
7. participation in the test	2

Student's workload

Source of workload	hours	ECTS
Total workload	103	4
Contact hours	53	2

Practical activities	43	2