COURSE DESCRIPTION CARD

BIALYSTOK UNIVERSITY OF TECHNOLOGY		**Faculty of Electrical Engineering**	
Field of study	Electrical Engineering	**Level and form of study**	Bachelor's degree
A group of modules /specialty	-	**Education profile**	-
Course name	Electrical Machines 1 **E**	**Course code**	IS-FEE-10075W
		Course type	*Elective*
Course form(s) and number of hours	**L C LC P SW FW S** 30 30	**Semester** **ECTS credits**	**Winter** **6**
The programme is valid from	2026/2027		
Introductory courses	-		
Course objectives	Increasing the knowledge and practical skills of analysis and operation of asynchronous machines and transformers.		
Framework programme content	Lecture: Asynchronous machines, single phase and three phase transformers: construction, machine windings, principles of operation. Magnetic circuits. Equivalent circuits in steady state of transformer and induction motor or induction generator. Performance characteristics of electrical machines. Energy losses and efficiency. Power flow in electrical machines. Specialization workshop: Experimental demonstration of hysteresis, magnetizing current waveform and transformer operation. Engineering calculations for electrical machines. Experimental demonstration of operation of ring and cage induction machine. Rotor current waveform.		
Other information about the course	content of the course refers to the principles of sustainable development the course develops practical skills		

Calculation:

Student workload related to:	**Total number of hours**	**including contact**	**including practical**
participation in lectures	30	30	
participation in other forms of activities	30	30	30
participation in an examination	14	14	
participation in consultations	6	6	3
completion of professional training	0	0	0
preparation for passing a lecture/an examination	10		
preparation for practical classes	30		30
case studies/homeworks	30		30
Total number of hours:	**150**	**80**	**93**
Total number of ECTS credits:	**6**	**3,2**	**3,7**

Expected discipline learning outcomes	Knowledge	Skills	Social competence

Objectives and framework content prepared by	PhD Eng. Andrzej Andrzejewski	Date:	10.02.2026

Implementation in the academic year **enter academic year**

Programme content

	Lecture
1	Introduction to the subject. Literature. Construction, windings, principles of operation of transformer. (2 hours).
2	Electric circuits and magnetic circuits of transformer. Magnetic equivalent circuit. Magnetic circuit with air gap. (2 hours).
3	Magnetization curve, saturation, hysteresis loops, hysteresis loss, eddy current loss in the ferromagnetic core. (2 hours).
4	Equivalent circuit of single-phase transformer. (2 hours).
5	Open circuit and short circuit tests of a single-phase transformer. (2 hours).
6	Transformer under load, voltage loss and drop. (2 hours).
7	Transformer energy losses and efficiency. (2 hours).
8	Three - phase transformers, construction, windings, principles of operation. (2 hours).
9	Connections of three phase transformers. (2 hours).
10	Induction machine, construction, windings and principles of operation. (2 hours).
11	Magnetic circuit of rotating machines. Generation of a rotating circular field. (2 hours).
12	Squirrel cage motors and slip ring motors. (2 hours).
13	Equivalent circuit of induction motor. (2 hours).
14	No – load test and blocked rotor test. (2 hours).
15	Motor power, torque-speed characteristics. (2 hours).
	Specialist workshop
1	Introduction to the subject. Overview of electrical machine construction. (2 hours).
2	Presentation of magnetic circuits. Experimental demonstration of hysteresis, magnetizing current waveform. (2 hours).
3	Calculations of simple magnetic circuits. (2 hours).
4	Determination of transformer parameters based on rated data. (2 hours).
5	Parameters calculation of transformer equivalent circuit. Analysis of short-circuit test and open circuit test of single phase transformer. (2 hours).
6	Calculations of selected transformer operation in steady states. (2 hours).
7	Matching three-phase transformers for a given connections. (2 hours).
8	Analysis of parallel operation of three phase transformers. (2 hours).
9	Analysis of results of the short-circuit test and the open circuit test of three phase transformer. (2 hours).
10	A demonstration of the operation of ring and cage machine. Rotor current waveform. (2 hours).

	11	Calculation of equivalent scheme parameters based on no-load state and blocked rotor test. (2 hours).
	12	Motor speed and torque calculations under different supply and load conditions. (2 hours).
	13	Analysis of three phase motor power losses. Power flow chart for motoring, generating and plugging. (2 hours).
	14	Analysis of speed control methods of three phase induction motor. (2 hours).
	15	Written test on transformers and induction motors. (2 hours).
Teaching methods (on-site classes)	L	Lecture
	SW	Demonstration of electric machine operation, problem-based learning.
Teaching methods (online classes)	-	
	-	
Forms of crediting	L	Oral exam on lecture content.
	SW	Written test of specialist workshop content.
Conditions of crediting	L	Student should prove the learning outcomes during oral exam.
	SW	Attendance to the classes. Student should prove the learning outcomes for SW during written test of speciazation workshop content.

Outcome symbols	**Expected learning outcomes**	**Expected learning outcomes defined for the field of study**		
		Knowlegde	Skills	Social competence
	Knowledge: the student knows and understands			
E1	the construction and the principle of operation of asychronous machine and transformer			
E2	equivalent circuit of electrical machine in steady state.			
E3	power losses analysis during energy conversion.			
	Skills: the student can			
E4	calculate engineering parameters for electrical machine			
E5	analyse connections of three phase transformer			
E6	assess electrical machine operation and features			
	Social competence: the student is ready to			

Outcome symbols	**Methods of verification of learning outcomes**	**Course form subject to verification**
E1	*Oral exam on lecture content.*	L
E2	*Oral exam on lecture content.*	L
E3	*Oral exam on lecture content.*	L
E4	*Attendance to the classes. Written test of speciazation workshop content.*	SW
E5	*Attendance to the classes. Written test of speciazation workshop content.*	SW
E6	*Attendance to the classes. Written test of speciazation workshop content.*	SW

Basic references	1	*Gerling D., Electrical Machines: Mathematical Fundamentals of Machine Topologies, Berlin, Heidelberg: Springer Berlin / Heidelberg, 2013.*
	2	*Szychta L., Szychta E., Gientkowski Z., Laboratory of electrical machines, Bydgoszcz : Wydaw. Uczelniane Uniwersytetu Technologiczno-Przyrodniczego w Bydgoszczy, 2019.*
	3	*Melkebeek, Jan A, Electrical Machines and Drives: Fundamentals and Advanced Modelling, Cham: Springer Nature, 1st ed., 2018 edition.*
	4	*Vukosavic S. N., Electrical Machines, New York, NY: Springer Nature, 2013.*
	5	*Yu, Qiang Y., Xuesong W., Yuhu Ch., Lisi T., Analysis and Mathematical Models of Canned Electrical Machine Drives: In Particular a Canned Switched Reluctance Machine, Singapore: Springer, 1st ed. 2019.*
Supplementary references	1	*Fuchs E. F., Masoum M. S., Power Quality in Power Systems and Electrical Machines, Academic Press, 2nd Edition, 2015.*
	2	*Chau, K. T., Electric Vehicle Machines and Drives: Design, Analysis and Application, Newark: Wiley, 2015.*
	3	*Pyrhonen J., Hrabovcova V., Jokinen T., Design of Rotating Electrical Machines, Newark: Wiley, 2009.*
	4	*Dehuai Z., Advances in Electrical Engineering and Electrical Machines, Berlin, Heidelberg: Springer Nature, 2011.*
	5	*Farshadnia M., Advanced theory of fractional-slot concentrated-wound permanent magnet synchronous machines, Singapore: Springer, 1st ed. 2018.*
	6	*Gerling D., Electrical machines and drives: mathematical fundamentals of machine topology, Springer, 2014.*
	7	*Drubel O., Converter Applications and their Influence on Large Electrical Machines, Berlin, Heidelberg: Springer Nature, 2013.*
	8	Husson R., Control methods for electrical machines, Newark: WILEY, 2010.
	9	Masmoudi A., Control Oriented Modelling of AC Electric Machines, Singapore: Springer,1st ed. 2018.
	10	Chakravorti S., Dey D., Chatterjee B., Recent Trends in the Condition Monitoring of Transformers: Theory, Implementation and Analysis London: Springer Nature, 2013.

Course coordinator	*PhD Eng. Andrzej Andrzejewski*	**Date:**	*10.02.2026*